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DOE/NASA CONTRACTOR
REPORT

DOE/NASA CR-161595

SOLAR HEATING, COOLING, AND DOMESTIC HOT WATER SYSTEM
INSTALLED AT KAW VALLEY STATE BANK AND TRUST COMPANY,
TOPEKA, KANSAS - FINAL REPORT

Prepared from documents furnished by

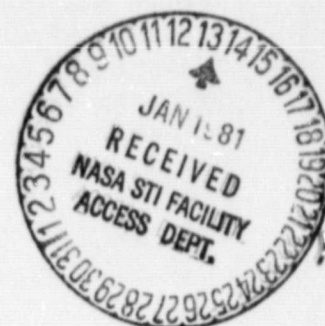
Kaw Valley State Bank and Trust Company
1944 North Topeka Avenue
Topeka, Kansas 66603

Under DOE Contract EG-77-A-01-4030

Monitored by

National Aeronautics and Space Administration
George C. Marshall Space Flight Center, Alabama 35812

For the U. S. Department of Energy



(NASA-CR-161595) SOLAR HEATING, COOLING,
AND DOMESTIC HOT WATER SYSTEM INSTALLED AT
KAW VALLEY STATE BANK AND TRUST COMPANY,
TOPEKA, KANSAS Final Report (Kaw Valley
State Bank and Trust Co.) 184 p

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U.S. Department of Energy



Solar Energy

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Summary

The Kaw Valley State Bank and Trust Company of Topeka, Kansas, is a recipient of a grant in the second cycle PON of the Demonstration Program to be applied to its north detached facility. This facility utilizes 72 General Electric evacuated tube, liquid collectors, creating 1068 square feet of effective collector area, which will heat an 1100 gallon thermal energy storage tank. Energy will be drawn from the tank as required to provide space heating by direct transfer to the supply air of the building environment. If cooling is required, the hot water from the storage tank will be used to fire four (4) staged, three (3) ton ARKLA absorption chillers, which in turn cools the supply air. The auxiliary energy source is a conventional natural gas fired boiler. The solar system at a cost of approximately \$94,000 is expected to provide 74 percent of the annual cooling load, 47 percent of the heating load, as well as 95 percent of the domestic hot water.

This project is the result of a dedicated joint effort of a team consisting of: The Kaw Valley State Bank and Trust Company, Mr. Glenn Swogger, President, is the owner of the facility; Robert S. Slemmons and Associates, Architects and Project Managers; Burgess Engineering, Inc., Solar Systems Engineering; General Electric, Procurement and Solar Collector Design; Ed Young Company, Solar System Contractor.

Project Description
Solar Heating, Cooling and Domestic Hot Water System
Kaw Valley State Bank and Trust Company
Topeka, Kansas

Abstract

Application - heating, cooling and domestic hot water
Collector Type - evacuated tube, hydronic collectors
Collector Manufacture - General Electric Corporation
Collector Area - 1068 square feet - 72 panels
Storage Capacity - 1100 gallon
Cooling Capacity - 12 ton (total) absorption chiller
Building Owner - Glenn Swogger, President, Kaw Valley State
Bank and Trust Company
Architects - Robert S. Slemmons and Associates
Engineer - Burgess Engineering Incorporated

Introduction

The Kaw Valley State Bank and Trust Company site is a commercial building in Topeka, Kansas. The building has approximately 5,600 square feet of conditioned space. Solar energy is used for space heating, space cooling, and preheating domestic hot water (DHW). The solar energy system has an array of evacuated tube-type collectors with an area of 1068 square feet. The array faces 5 degrees east of south at an angle of 45 degrees to the horizontal. A 50/50 solution of ethylene glycol and water is the transfer medium that delivers solar energy to a tube-in-shell heat exchanger that in turn delivers solar-heated water to a 1100-gallon pressurized hot water storage tank. This heat-exchanger-to-storage loop is plumbed in parallel to a second tube-in-shell heat exchanger that provides preheated DHW to a gas-fired hot water heater. When solar energy is insufficient to satisfy the space heating and/or cooling demand, a natural gas-fired boiler provides auxiliary energy to the fan coil loops and/or the absorption chillers. Since the DHW load is very low, the DHW system is not instrumented. The solar energy and heating, ventilating and air conditioning systems are fully automated, requiring only a manual seasonal changeover.

Design Philosophy

The underlying philosophy of this project was the concept to truly achieve maximum energy conservation. Energy conscious design was employed throughout all phases of this integrated project. ASHRAE Standard 90-75 was used as a guideline in the selection of materials and systems of construction in the design of the structure. In general, all components exceed the standard. Design of the structure features such concepts as maximum massing for thermal storage and improved insulation systems. Special consideration has been

given to the orientation and detailed assembly of glazed opening. Windows have been held to a minimum and utilizes solar-bronze reflective insulating glass. Entrance and windows have been provided with seasonal control of solar gain. Even landscaped planting has been planned as an integral part of the seasonal control on the west facade. Fifty percent of the usable floor space is constructed subgrade to reduce heat loss or gain. Two directions of approach have been employed to insure maximum energy conservation of the mechanical system. The first being the design of a system utilizing energy efficient components integrated into a high efficiency heating, cooling, hot water system. The second approach is one of guidelines for efficient and proper operation of said system. A complex network of controls evolved from the need for maximum automation to insure proper system operation. The control system was designed to respond to the requirements of the mechanical system, the needs of the building environment and the ambient climatic conditions. An example of this feature is that the hot water operating temperature of the system during the heating cycle is governed by the ambient air temperature to minimize the enthalpy requirements. This will minimize the heat loss as well as extend the operative range of the building. The operating temperature of the circulating hot water during the cooling cycle is designed to maintain 195°F to insure maximum efficiency of the absorption chillers. The chillers are staged to insure minimum energy drawn from the storage tank. A two zone, variable volume forced air distribution system is utilized to provide individual room temperature control so as to eliminate energy waste through over heating or cooling. Thus the room automatically maintains the desired building temperatures of 70°F in the winter and 75°F in the summer. Fresh air ventilation is designed to be controlled by an economizer which governs the volume of fresh air with respect to the outdoor ambient air temperature. The economizer will also free cooling during near passive situations. Electronic air filters will assist in odor control thus decreasing the need for outdoor fresh air.

Upon the preceding criteria, design evolved into establishing the proper operation of the system. As previously stated, the system is totally automated. The system was designed for a twelve hour operation of the cooling equipment, with an eight hour operation of ventilation. There would be a ten-degree setback from 10:00 p.m., to 6:00 a.m., of the heat equipment; this would save an anticipated 12 percent of the energy requirement. In the heating season, humidification will be discontinued after working hours and on weekends. All time controls are supplied with manual overrides to allow weekend shutdown of one or both zones. A rigid schedule of maintenance, such as filter cleansing, control checking, operating temperature monitoring, etc., shall be mandatory.

The 1068 square feet of collectors was selected as a trade off between percent of load solar subsidized and available building area. Evacuated tube type collectors allow for a maximum system operating temperature of 250°F, thus extending energy storage capacity of the storage tank which is critical for the chiller equipment. The 1100 gallon storage tank also reflects this desire to maximize the higher operating range. It was decided to maximize

the subsidizing of the cooling load due to the considerable higher cost of electric cooling as opposed to gas heating. However, the auxiliary gas boiler offers the facility the potential to convert to a great variety of backup energy sources (i.e., electricity, oil, coal, wood, or combustible waste) when the need arises in the future. This offers a great deal of security to the bank in addition to the energy savings.

Operation of the System - The system, as shown schematically in Figure 1, has five modes of operation:

1. Mode 1 - Collector Loop Operation - This mode activates when there is a minimum insolation intensity of 35 Btu per square foot per hour. When this occurs, the collector pump turns on. This mode terminates when insolation intensity drops below 35 Btu per square foot per hour. A bypass valve prevents flow through the collector-to-storage heat exchanger until the loop temperature exceeds 75°F. If a pump or a power failure occurs during operation, collector system operation may be prohibited for up to 24 hours until the array has cooled down.

2. Mode 2 - Heat Rejection Operation - This mode activates whenever the collector outlet temperature exceeds the recommended ethylene glycol maximum temperature of 280°F. A three-way valve in the collector loop redirects collector flow through the heat rejector which rejects collected energy until the collector outlet temperature drops to a safe predetermined value.

3. Mode 3 - Collector Loop to Storage - Mode 3 activates when Mode 1 operation results in the collector outlet temperature exceeding the storage tank temperature by at least 18°F, turning on pump P2. Mode 3 terminates whenever Mode 1 is terminated or when the measured temperature differential falls below a set minimum temperature (nominally 3°F).

4. Mode 4 - Solar Energy DHW Pre heating - This mode activates only when Mode 3 has been entered and DHW consumption permits pre-heating of the cold water supply. This occurs when the cold water passes through a liquid-to-liquid heat exchanger in parallel with the collector-to-storage loop.

5. Mode 5 - Storage to Heating, Ventilating, and Air Conditioning (HVAC) Loads - This mode activates when the normally closed valve V15 is opened, and valve V2 is repositioned by the control system to permit flow through the hot water storage tank, using the stored solar energy for HVAC loads. Valve V15 is opened whenever a HVAC load requires hot water flow and storage tank temperatures exceed HVAC return flow (heating or cooling) temperature by 20°F.

- T155 COLLECTOR PLANE TOTAL IRRADIATION
- T201 OUTDOOR TEMPERATURE
- T200 INDOOR TEMPERATURE

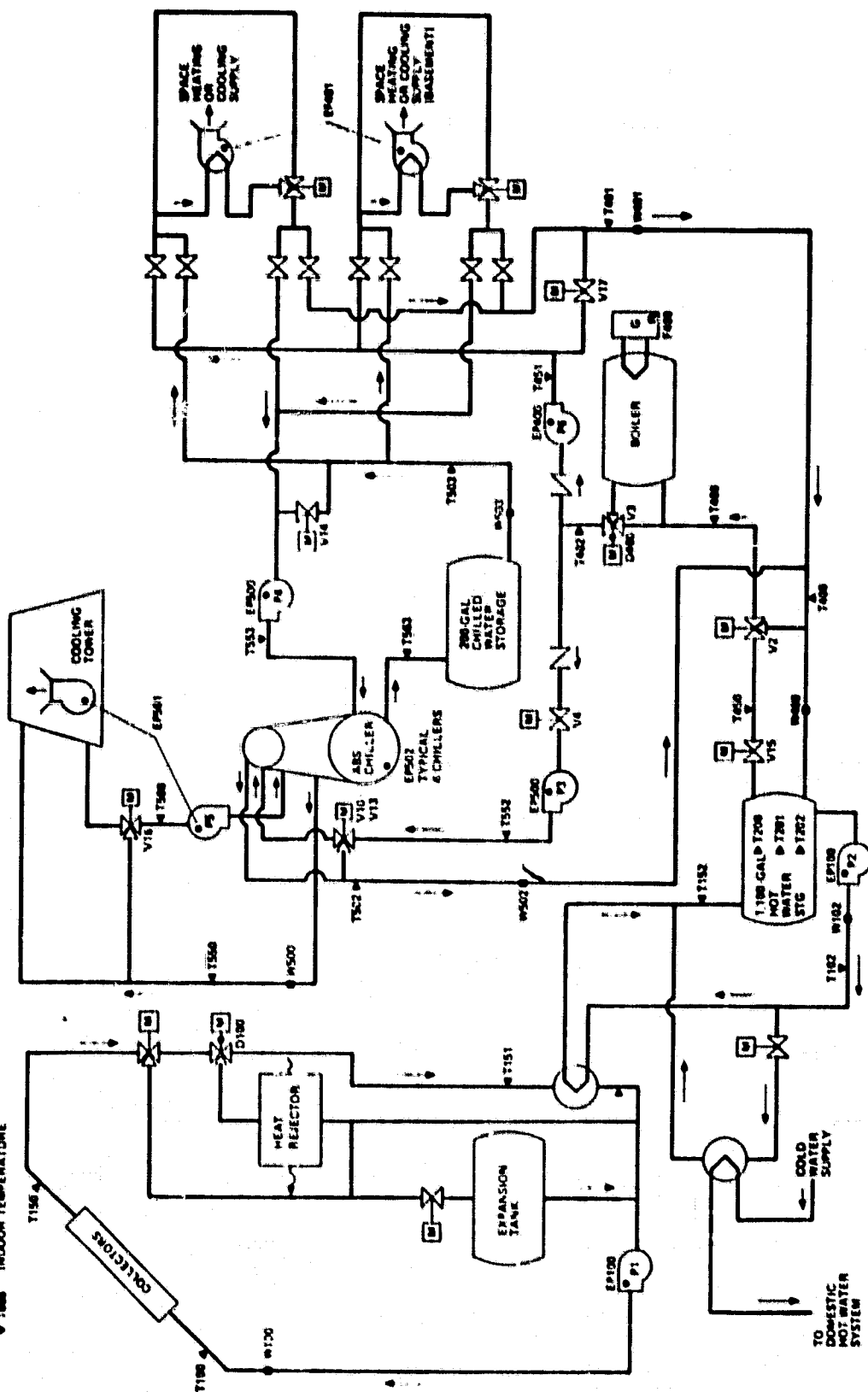


Figure 1. KAW VALLEY STATE BANK SOLAR ENERGY SYSTEM SCHEMATIC

Problems/Solutions

The contractor found the design of the evacuated tube collectors very sound in solar thermal theory. However, the contractor was confronted by several problems in the mechanics of the collector system.

There are several inherent problems associated with available General Electric Corporations evacuated tube collectors. The most obvious of which is the fragile nature of the tubes. At the high stagnation temperature which might be encountered, thermal shock of the tubes becomes a serious threat. To prevent damage, it becomes necessary to provide a means to dump excess heat in times when the storage tank has reached its upper limit. This implies a considerable cost of exchangers and controls. It also expands energy to operate the over temperature dump system without offering any added solar benefit to the building. It was also considered desirable to cover tubes with lexan for protection from hail and vandalism, which will jeopardize a portion of the solar gain.

Another major concern is the inability to completely drain the collectors. Problems could possibly arise when some collectors are empty while others are full and the system is allowed to stagnate, such could be the case in a maintenance or service situation. What might occur is that the empty tubes would approach 700°F, while the filled tubes would be boiling off and problems of thermal shock would result as 220°F water vapor met 700°F tubes.

Another problem encountered was the integration didn't sense the collector temperature but only the available energy. In this failure, the collectors were turned on when covered with ice and snow and the subfreezing glycol solution pumped through a heat exchanger interfacing with water. The HEX froze and ruptured, subsequently allowing the glycol solution in the collectors to be diluted with enough water to freeze and rupture the collector tubes. The system was modified and the modification consisted of installing a 2 inch diverting valve that is temperature controlled as to normally pass flow from "A" to "B" allowing the collector fluid to be circulated through the heat exchanger. When the temperature drops to 65°F, the valve will return to the "A" to "C" position. A final safety feature is controller S-2, which will cut off the collector pump if it sees a temperature of 40°F or less. The system will then remain off until manually reset. This combination of safety features should prevent any chance of freeze up from occurring.

The secondary heating/cooling system creates no major problems since it is basic to many conventional systems developed, engineered, and proven over many years.

The architect, through time and deliberation, integrated the solar system into the design in such a manner as to create a very marketable building of extremely pleasing aesthetics. This is lending greatly to the rapidly growing public enthusiasm in the project.

Solar Acceptance Test

An Acceptance Test was conducted on July 30, 1980, with Mr. William A. Hagen, P.E., Government Project Manager; Bob Slemmons, Architect; Lyle Dreher, Maintenance Contractor; Glenn Swogger, President Kaw Valley State Bank and Trust Company; and Mr. Ron Toelle, Government Project Engineer.

The following five pages are extracts from site files relating to the Acceptance Test and suggested system improvements as a result of the Acceptance Test.



**SLEMMONS ASSOCIATES
ARCHITECTS, P.A.**

SUITE 1515, 1 TOWNSITE PLAZA
Topeka, KS 66603 913/234-2244

ROBERT S. SLEMMONS, A.I.A., PRESIDENT

ASSOCIATES:

DAVID A. HOUSER, A.I.A.
GREGORY D. SIMS, A.I.A.

September 26, 1980

Mr. Bill Hagen
Government Project Manager
NASA
George C. Marshall Space Flight Center
Marshall Space Flight Center, AL 35812

Code FA33

Re: EG-77-A-01-4080

Dear Sir:

Under separate cover I am sending two sets of Maintenance and Operating Manuals for the Solar Energy System for Kaw Valley State Bank - North, Topeka. These include as-built drawings with all modifications to date.

Enclosed is a letter to you from Mr. Swogger, President of the Bank, relative to the understanding the system is operational and functioning as intended.

We are proceeding with requests for proposals from the Contractor to construct additional modifications recommended by Ron Toelle with concurrence of W. E. Burgess, P.E., our consulting engineer. These changes should improve the function and reliability of the chillers as well as the S.D.A.S. No changes have been made since your visit (relative to high fossil-fuel consumption) pending some determination of cost for the modifications. You'll be advised when added work is authorized.

Sincerely,

Robert S. Slemmons, AIA

Encl.

cc: Mr. Glenn Swogger
Dahlstrom & Ferrell

RSS/pk

Kaw Valley

STATE BANK AND TRUST CO.
P.O. BOX 8000
PHONE 232-8742
1110 NORTH KANSAS AVE
TOPEKA, KANSAS 66608



GLENN SWOGGER, PRESIDENT
NORMAN COWPERTHWAIT, VICE PRESIDENT
C. H. HAYNES, CASHIER
CECIL MATHENY, ASST. VICE PRESIDENT
RUSSELL PERCIVAL, ASST. VICE PRESIDENT
RANDALL CURRIE, MANAGING OFFICER
SEA HOLTMAYER, CUSTOMER RELATIONS OFFICER
ROBERT S. MAXWELL, TRUST OFFICER

ANN MORRISSEY, OPERATIONS OFFICER
MARY L. WILLIAMS, VICE PRESIDENT
GARY C. MYERS, ASST. VICE PRESIDENT
GERALD W. LAUBER, EXECUTIVE VICE PRESIDENT
RACHAEL GILBERT, ASST. TRUST OFFICER
HOWARD ALEXANDER, VICE PRESIDENT
CLARENCE J. TYLER, BLDG. SUPT.
BEVERLY HADLEY, ASST. VICE PRESIDENT

September 23, 1980

CAPITAL \$600,000.00
SURPLUS AND PROFITS \$4,000,000.00
TOPEKA, KANSAS 66608

Mr. William A. Hagen, P.E.
Solar Heating & Cooling Program, FA 34
Marshall Space Flight Center, AL 35812

Dear Bill:

Your visit of July 30, 1980 allowed our Architect, Bob Slemmons, our maintenance contractor, Lyle Dreher and others associated with this solar project to meet with you and Mr. Toelle. My discussion with you at noon confirmed that you found all things in order.

Based upon the tests which have been conducted and the counsel of my Architect, Bob Slemmons, I declare the Solar System operational.

We will be supplying you with "as built" drawings, plus operation and maintenance manuals as part of our final report. We recognize that this solar demonstration was a pioneering activity. The cost benefits may not be immediate but energy conservation is necessary action which all of us must take.

Sincerely,

Glenn Swogger
Glenn Swogger
President

GS/j1

ORIGINAL PAGE 1
OF FOUR ORIGINALS



**SLEMMONS ASSOCIATES
ARCHITECTS, P.A.**

SUITE 1515, 1 TOWNSITE PLAZA
Topeka, KS 66603 913/236-9244

ROBERT S. SLEMMONS, A.I.A., PRESIDENT

ASSOCIATES:

DAVID A. HOUSER, A.I.A.

GREGORY D. SIMS, A.I.A.

September 26, 1980

Dahlstrom & Ferrell Construction Company, Inc.

P. O. Box 4561

Topeka, Kansas 66604

Re: Kaw Valley State Bank - North Solar

Gentlemen:

Please submit your proposal to provide additional work recommended by the Government Project Engineer, Mr. Ron Toelle, with concurrence of our engineering consultant, Mr. W. E. Burgess, P.E. and described as follows:

1. Provide new openings with louvers, grilles, filters, etc. conforming to Drawing SR-1, attached, to ventilate the ATM Room and Mechanical Equipment Room 200. Install a hinged type of soffit louver where indicated, with filter rack and permanent washable removable filters.

2. Install air vent on cooling tower piping in close proximity to strainer as described in notes from Ron Toelle's visit (attached).

3. Install aquastat to inhibit boiler operation when solar heated water is available, in accordance with notes from Ron Toelle's visit (attached).

Yours truly,

Robert S. Slemmons, AIA

Encl.

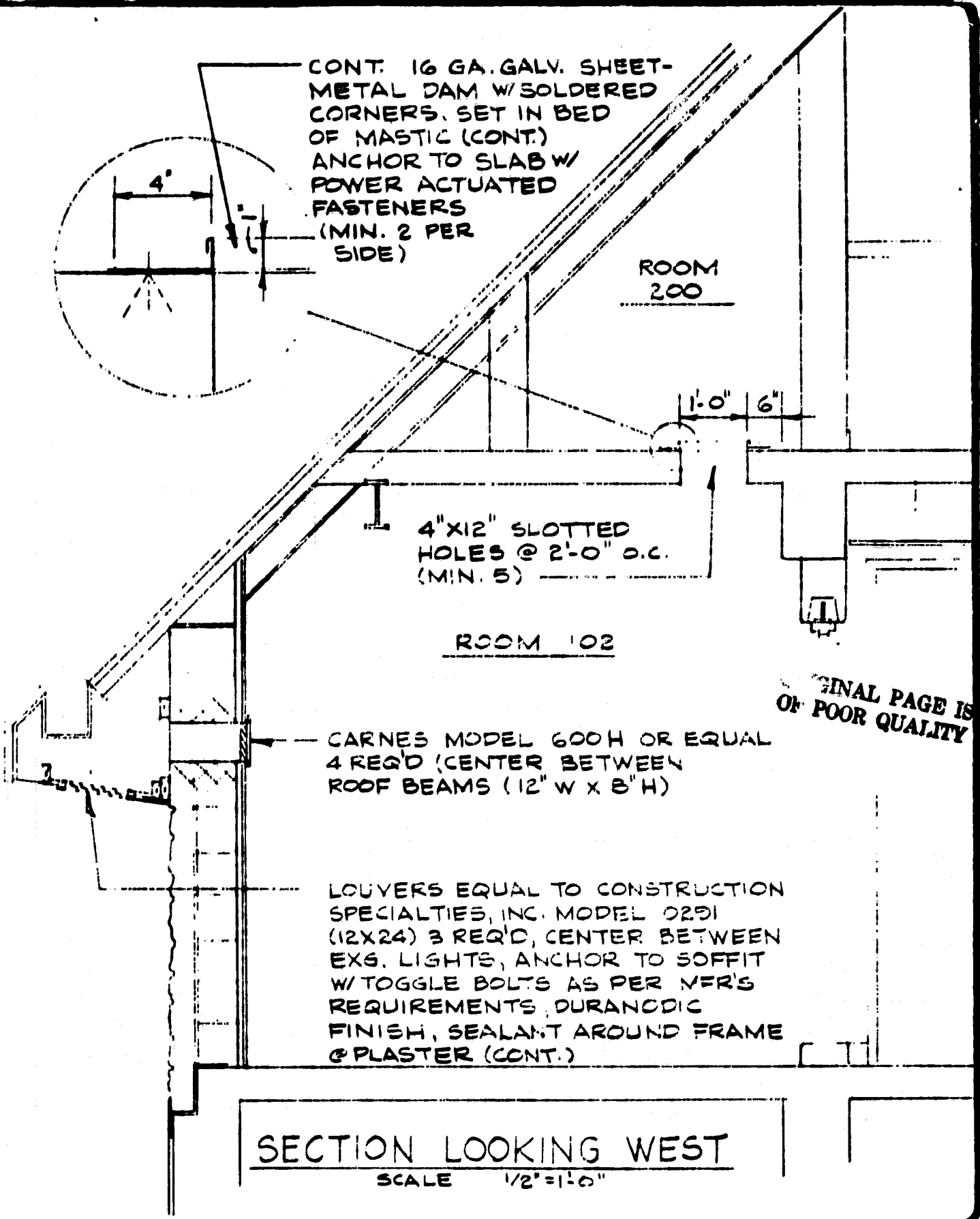
**cc: Young's Inc.
Mr. Glenn Swogger
✓ Mr. Bill Hagen**

RSS/pk

Ron Toelle's notes on visitation to KAW VALLEY STATE BANK - NORTH

Suggested System Improvements as discussed July 30, 1980.

1. Venting at a high point. An air vent should be added to the cooling tower piping in close proximity to the strainer. An existing pressure gauge port for P5 located next to the cleanout strainer would serve very well. Upon cleaning the strainer, air could be immediately vented, thus averting a potential air lock in the chillers.
2. An adjustable aquastat with a strap on bulb should be used in a control modification which would inhibit the boiler when solar water is available to the chillers at X° (say 190°F). The exact set point can be adjusted for minimum fuel consumption while maintaining comfort.
3. Modulating the input water temperature to the chiller for load balancing should be validated again by ARKLA. Excessive fuel useage would be expected if this is done with the boiler. Reducing the firing temperature to the ARKLA greatly reduces the COP of the unit.
4. Assure that the boiler is never used to heat the solar storage tank. This reduces the efficiency of the solar collectors while creating excessive fuel bills.



SECTION LOOKING WEST

SCALE 1/2" = 1'-0"

KAW VALLEY STATE
BANK & TRUST CO.
NORTH FACILITY



SLEMMONS ASSOCIATES
ARCHITECTS. P. A.
SUITE 1015 TOWNSITE PLAZA
TOMBIG, MS 38683 601-226-8244

DATE: 9-26-80

DRAWN BY: G. D.S.

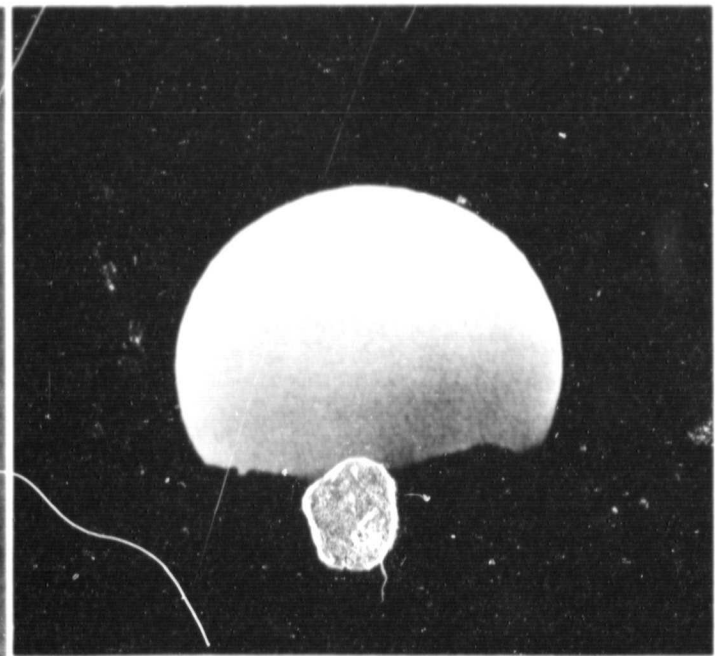
REVISION SHEET

SR-1

APPENDIX A

Manufacturers Literature

ARKLA Absorption Chiller



solaire[®] **36**

3 ton
Absorption Chiller
for Solar Air
Conditioning

Model No. WT-36

Installation and
Start-up
Data

ARKLA

solaire[®]

SUN POWERED AIR CONDITIONING

A product of Arkla Industries Inc.

General Description

Arkla's Solaire 36 water chiller is designed primarily for solar-operated comfort air conditioning applications, but can also be used in small industrial process cooling applications. The unit is nominally rated at 3 tons, but design flexibility allows for operation over a wide range of cooling capacities. With firing water temperature between 170°F and 205°F, and with 85°F entering condensing water, the chiller can produce from 1.5 tons to 3.5 tons of cooling.

Features

- The special lithium bromide/water solution is installed at the factory. The low concentration of this special solution virtually eliminates the possibility of crystallization.
- Each unit is given a complete capacity test at the factory to assure performance according to specifications.
- A small, hermetically sealed stainless steel centrifugal pump transfers solution from the low pressure side to the high pressure side of the absorption cycle.
- The combination of the solution pump and an abundance of heat transfer surface permits this unit to produce practical cooling capacity from relatively low firing water temperatures.
- The generator tubes are of type 304 stainless steel which is also used in other vital areas to insure years of trouble free service.
- Noise and vibration have been reduced to insignificant levels.

Operating Controls

- **Solution By-Pass Valve and Thermostatic Switch**—The switch senses refrigerant temperature in the evaporator. On a drop in temperature to approximately 36°F the switch opens the by-pass valve, allowing most of the absorbent liquid to by-pass the absorber coil, which helps to prevent shut-down by the evaporator low temperature switch.
- **Solution Pump Relay**—This relay controls the operation of the lithium bromide-water solution pump.
- **Chilled Water Pump Relay**—This relay has two sets of contacts. One set of contacts will control chilled water pump operation through an external relay. The other set of contacts, in series with a set of contacts on the condensing water pump relay, helps to control solution pump operation, and, through an external relay, the operation of the hot water pump.
- **Condensing Water Pump Relay**—This relay has two sets of contacts. One set of contacts controls condensing water pump operation through an external relay. The function of the other set of contacts is explained under Chilled Water Pump Relay.
- **Heavy Duty Transformer**—The 24 volt transformer has 50 VA output, providing ample power to operate the unit controls and to energize the holding coils of external relays through the switching action of the control relays described above.

*External relays not furnished by Arkla.

Safety Controls

- **Evaporator Low Temperature Limit Switch**—If the refrigerant temperature falls below minimums, this safety switch will shut down the hot water pump, the solution pump, and the condensing water pump.
- **Condenser High Temperature Limit Switch**—If the condenser temperature rises above acceptable limits, this safety switch will shut down the hot water pump, the solution pump, and the chilled water pump.

SPECIFICATIONS MODEL WF 36

DESIGN DELIVERED CAPACITY, Btu/h..... 36,000¹
DESIGN DELIVERED CAPACITY, Tons I.M.E..... 3.0¹

ENERGY REQUIREMENTS

Design Hot Water Input, Btu/h..... 50,000
 Design Hot Water Inlet Temperature, °F..... 195
 Design Hot Water Outlet Temperature, °F..... 185.9
 Permissible Range of Inlet Temp..... 170 to 205
 Design Hot Water Flow, gpm..... 11.0
 Pressure Drop, Feet of Water, at 11 gpm..... 9.8
 Permissible Range of Flow, gpm..... 5 to 22
 Pressure Drop, Feet of Water, at 22 gpm..... 29.9
 Maximum Working Pressure, psig..... 100
 Unit Water Volume, Gallons, Approx..... 3.0
 Electrical Voltage, 60 Hz, 1 Phase..... 115²
 Maximum Wattage Draw..... 250

CHILLED WATER DATA

Design Inlet Temperature, °F..... 55
 Design Outlet Temperature, °F..... 45
 Design Flow, gpm..... 7.2
 Pressure Drop, Feet of Water, at 7.2 gpm..... 4.6
 Permissible Range of Flow, gpm..... 4 to 13
 Pressure Drop, Feet of Water, at 13 gpm..... 12.5
 Maximum Working Pressure, psig..... 100
 Unit Water Volume, Gallons, Approx..... 1.5

CONDENSING WATER DATA

Design Heat Rejection, Btu/h..... 86,000
 Design Inlet Temperature, °F..... 85
 Design Outlet Temperature, °F..... 99.3
 Permissible Range of Inlet Temp..... 75 to 90
 Design Flow, gpm..... 12.0
 Pressure Drop, Feet of Water, at 12 gpm..... 9.6
 Permissible Range of Flow, gpm..... 9 to 25
 Pressure Drop, Feet of Water, at 25 gpm..... 33.9
 Maximum Working Pressure, psig..... 100
 Unit Water Volume, Gallons, Approx..... 3.0

FOR COOLING TOWER SELECTION

Maximum Heat Rejection, Btu/h..... 106,000
 Range, °F..... 14 to 17
 Minimum Permissible Sump Temperature, °F..... 75³

SERVICE CONNECTIONS

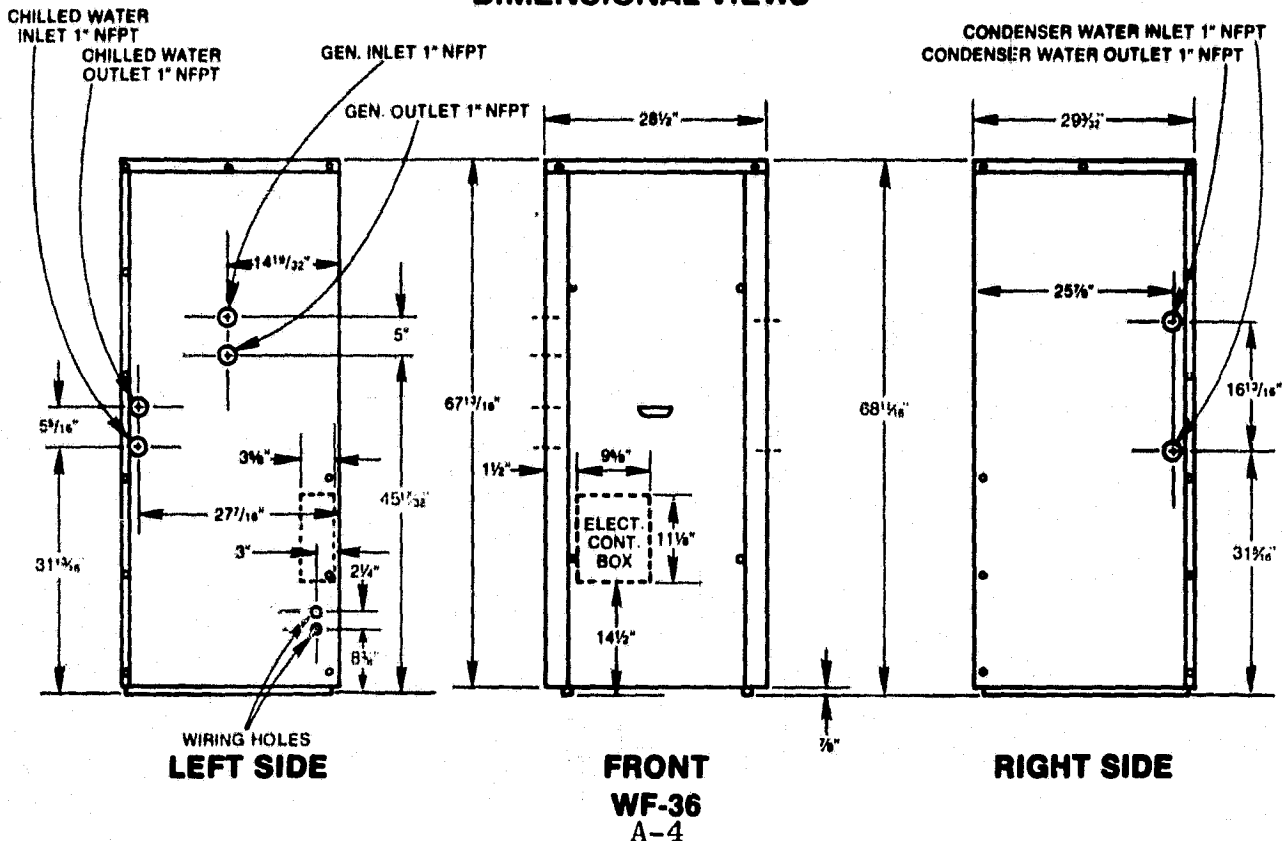
Hot Water Inlet and Outlet..... 1" FPT
 Chilled Water Inlet and Outlet..... 1" FPT
 Condensing Water Inlet and Outlet..... 1" FPT

PHYSICAL DATA, APPROXIMATES

Operating Weight, Pounds..... 675⁴
 Shipping Weight, Pounds..... 680⁵
 Crated Size, Inches..... 36W, 34D, 75H

- NOTES:** 1. Capacity at design conditions. For capacities at other conditions, see Page 4.
 2. Units equipped for operation on 230V-50Hz-1Ph available on special order.
 3. Thermostatic switch to control tower fan **MUST** be used. Set to "cut out" at 75°F.
 4. Includes circulating water weights.
 5. Units as shipped contain Lithium Bromide charge.

DIMENSIONAL VIEWS



MODEL WF 36

Hot Water Flow 11.0 GPM
 Condensing Water Flow 12.0 GPM
 Chilled Water Flow 7.2 GPM
 Chilled Water Leaving Temperature 45° F

HOT WATER		ENERGY INPUT BTU/H	INLET COND. WATER TEMP	DELIVERED CAPACITY		REJECTED HEAT BTU/H
INLET TEMP	OUTLET TEMP			BTU/H	TONS	
170° F	167.0	16,400	80° F	9,700	0.81	26,100
	167.4	14,500	85° F	6,400	0.53	20,900
	*	*	90° F	*	*	*
175° F	170.7	23,800	80° F	17,300	1.44	41,100
	171.1	21,600	85° F	13,100	1.09	34,700
	*	*	90° F	*	*	*
180° F	174.3	31,200	80° F	24,400	2.03	55,600
	174.8	28,800	85° F	19,400	1.62	48,200
	175.7	23,800	90° F	14,200	1.18	38,000
185° F	178.0	38,400	80° F	31,100	2.59	69,500
	178.5	35,900	85° F	25,600	2.13	61,500
	179.4	30,600	90° F	19,300	1.61	49,900
190° F	181.7	45,800	80° F	36,800	3.07	82,600
	182.2	42,900	85° F	31,300	2.61	74,200
	183.2	37,500	90° F	23,800	1.98	61,300
195° F**	185.3	53,100	80° F	40,600	3.38	93,700
	185.9	50,000	85° F	36,000	3.00	86,000
	186.9	44,300	90° F	27,600	2.30	71,900
200° F	189.3	58,800	80° F	41,200	3.48	100,600
	189.8	56,000	85° F	40,200	3.35	96,200
	190.7	51,000	90° F	30,500	2.54	80,500
205° F	193.4	63,800	80° F	42,000	3.50	105,800
	193.9	60,800	85° F	42,000	3.50	103,800
	194.6	56,200	90° F	32,500	2.71	88,700

*Unit operation unstable in these areas **Lighter area represents conditions for rated capacity

MODEL WF 36 Pressure Drops vs Water Flows For Pump Sizing

FLOW, GPM	PRESSURE DROP, FEET OF WATER		
	CHILLED WATER	HOT WATER	CONDENSING WATER
4	1.7 Min.		
5	2.5	2.8 Min.	
6	3.4	3.7	
7	4.4	4.7	
7.2	4.6		
8	5.5	5.9	
9	6.8	7.1	5.8 Min.
10	8.1	8.4	7.0
11	9.4	9.8	8.3
12	10.9	11.3	9.6
13	12.5 Max.	12.8	11.0
14		14.4	12.5
15		16.1	14.2
16		17.8	15.8
22		29.9 Max.	27.4
25			33.9 Max.

Where Progress Is Built On Quality

Arkla Industries Inc.
 P.O. Box 534
 Evansville, IN 47704

Arkla Industries Inc. reserves the right to change the specifications and design of its products without notice and without incurring obligation.

FORM NO. SP-1-5-1, NOV. 1976

PRINTED IN USA

DATE: Nov., 1976

CONDENSING WATER PIPING - AT UNIT

MODELS

WF-36

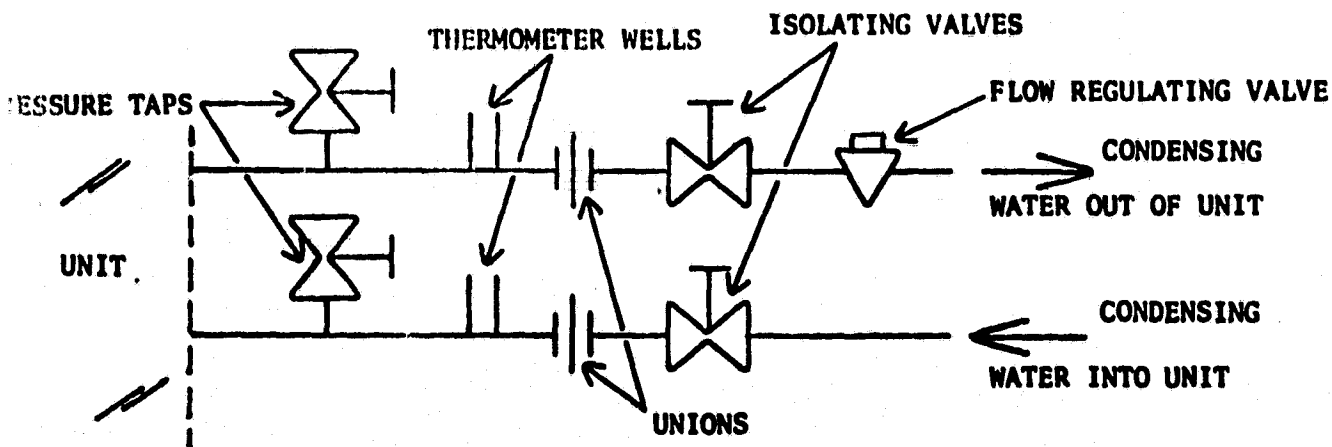
Both inlet and outlet condensing water connections are located on the right side near the rear. The inlet connection is the bottom pipe and is a 1" FPT fitting. The outlet connection is the top pipe and is a 1" FPT fitting.

Any vertical piping to these connections should be far enough away from the panel to permit easy removal of this panel if necessary.

Certain fittings should be installed in the condensing water piping as shown in Figure below, for the reasons mentioned below.

- A 1/4" pet cock should be installed in the inlet and outlet connection next to the unit. These are needed to take pressures when adjusting the water flow.
- A union and an isolating valve (Gate valve) should be installed in each line so the piping can be disconnected from the unit without making it necessary to drain the water from the rest of the system.
- A flow regulating valve (plug cock) should be located in the water line leaving the unit and down stream of the isolating valve for the purpose of balancing and regulating condensing water flow.
- "Blow down" valves should be installed at end of dirt legs to make it convenient for draining off sediment or draining the unit, if necessary.

One of the six thermometer well fittings shipped (in a carton behind the front panel) with each unit is to be installed in each the inlet and outlet condensing water lines. For the most accurate temperature readings, these should be located as close to the unit as possible. They must be installed in horizontal lines with the well part of the fittings in the vertical up position.



HOT WATER PIPING

The WF-36 requires a hot water supply of 11 G.P.M. at 170°F to 195°F. The unit produces 36,000 BTU's of cooling at 195°F hot water and 85°F condensing water.

WF-36

Only clean, hot water, free from oil and other foreign materials should be used. If any other hot liquid or mixture is going to be used, check with Arkla Industries Inc. P.O. Box 534, Evansville, Indiana 47704, for particulars. All hot water piping, including return piping should be installed in accordance with good hot water piping practice (See 111-20-1).

See Figure on 111-52-4(B), for the proper hot water piping connections to the unit.

Any vertical piping to these connections should be far enough away from the panel to permit easy removal of this panel if necessary.

Certain fittings should be installed in the hot water piping as shown in Figure on 111-52-4(B) for the reasons mentioned below.

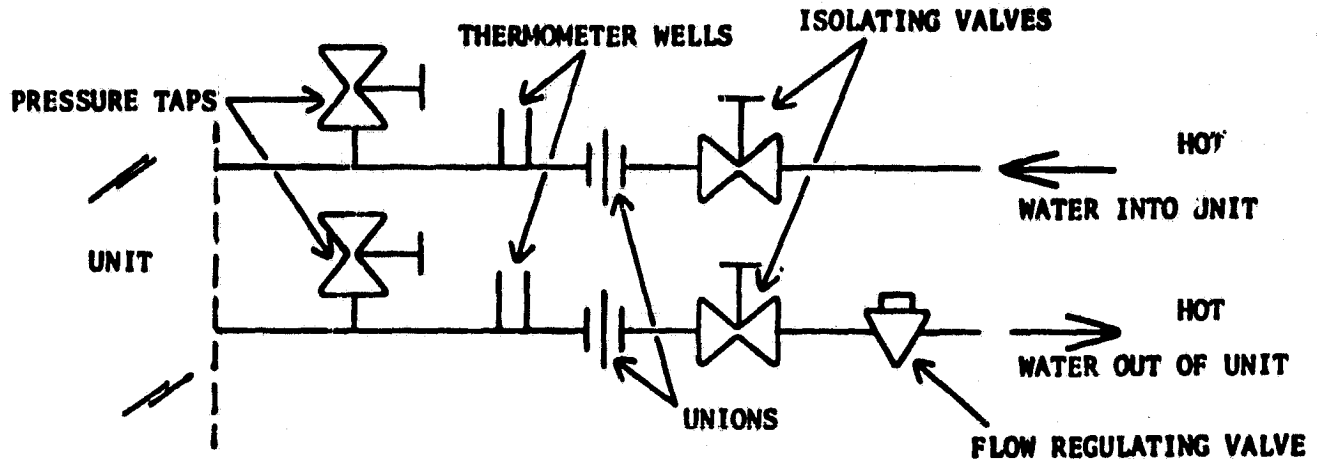
- a. A 1/4" pet cock should be installed in the inlet and outlet connection next to the unit. These are needed to take pressures when adjusting the water flow.
- b. A union and an isolating valve (Gate valve) should be installed in each line so the piping can be disconnected from the unit without making it necessary to drain the water from the rest of the system.
- c. A flow regulating valve (plug cock) should be located in the water line leaving the unit and down stream of the isolating valve for the purpose of balancing and regulating hot water flow.
- d. "Blow down" valves should be installed at end of dirt legs to make it convenient for draining off sediment or draining the unit, if necessary.

One of the six thermometer well fittings shipped (in a carton behind the front panel) with each unit is to be installed in each the inlet and outlet hot water lines. For the most accurate temperature readings, these should be located as close to the unit as possible. They must be installed in horizontal lines with the well part of the fittings in the vertical up position.

The hot water supply and return lines should be insulated at least up to the point of connection on the unit to reduce heat loss and to avoid injury to personnel.

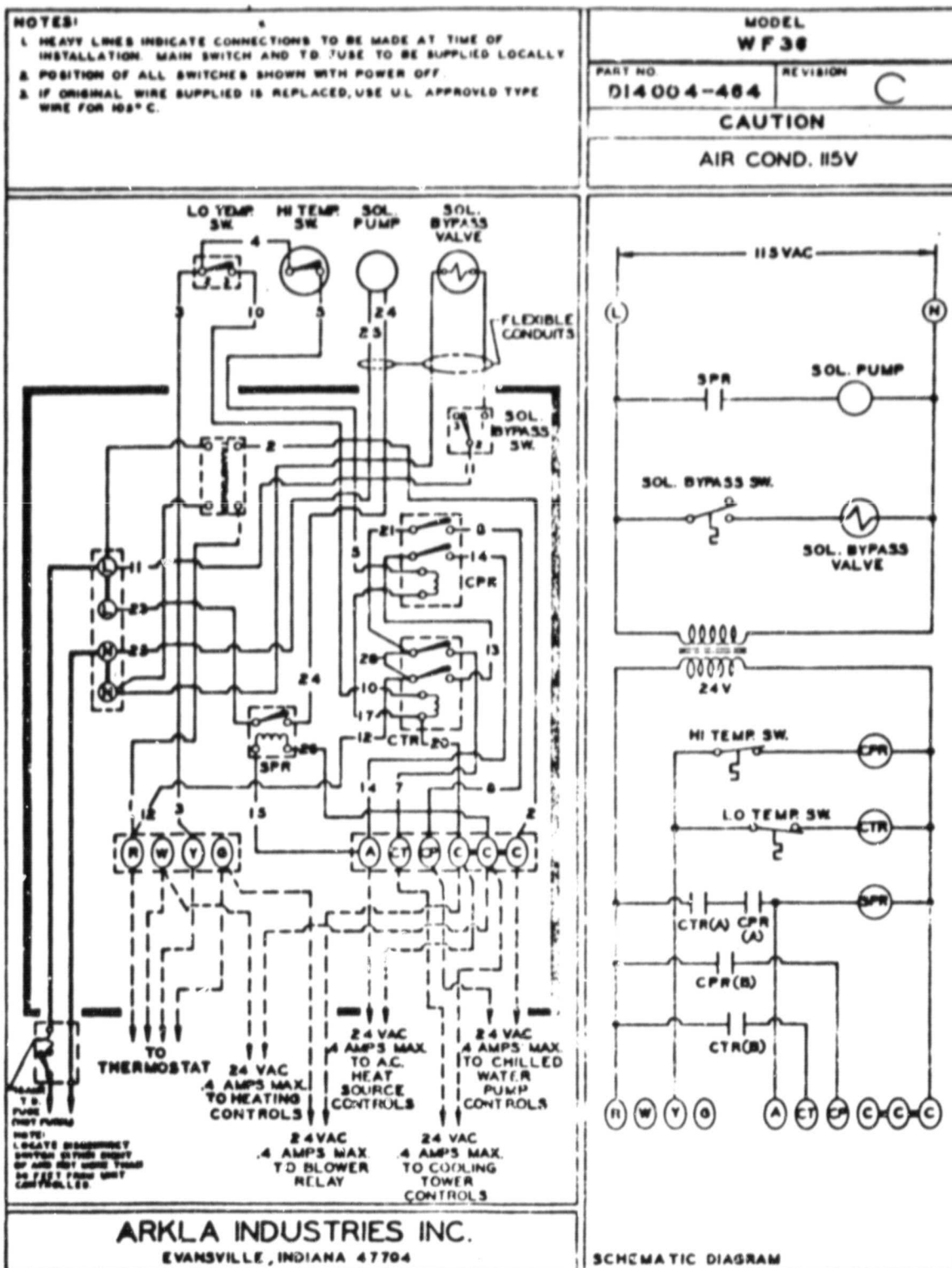
Low water flow will reduce effective cooling and waste energy. It is recommended that a flow switch be a part of the control system to cut off the unit at a minimum flow rate of 5 G.P.M.

It is recommended that some type of minimum and maximum input control system be installed. This must be field fabricated and installed. Minimum input is 170°F hot water. Maximum input is 205°F hot water. Water temperatures below 170°F produce no effective cooling and wastes energy. At water temperatures above 205°F the unit again wastes energy.



DATE: Nov., 1976

MODELS

WF-36
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DATE: Nov., 1976

MODELS

ELECTRICAL CONNECTIONS - TO UNIT

The Arkla Solaire unit is wired for operation on 115 volts, 1 phase, 60 cycle current.

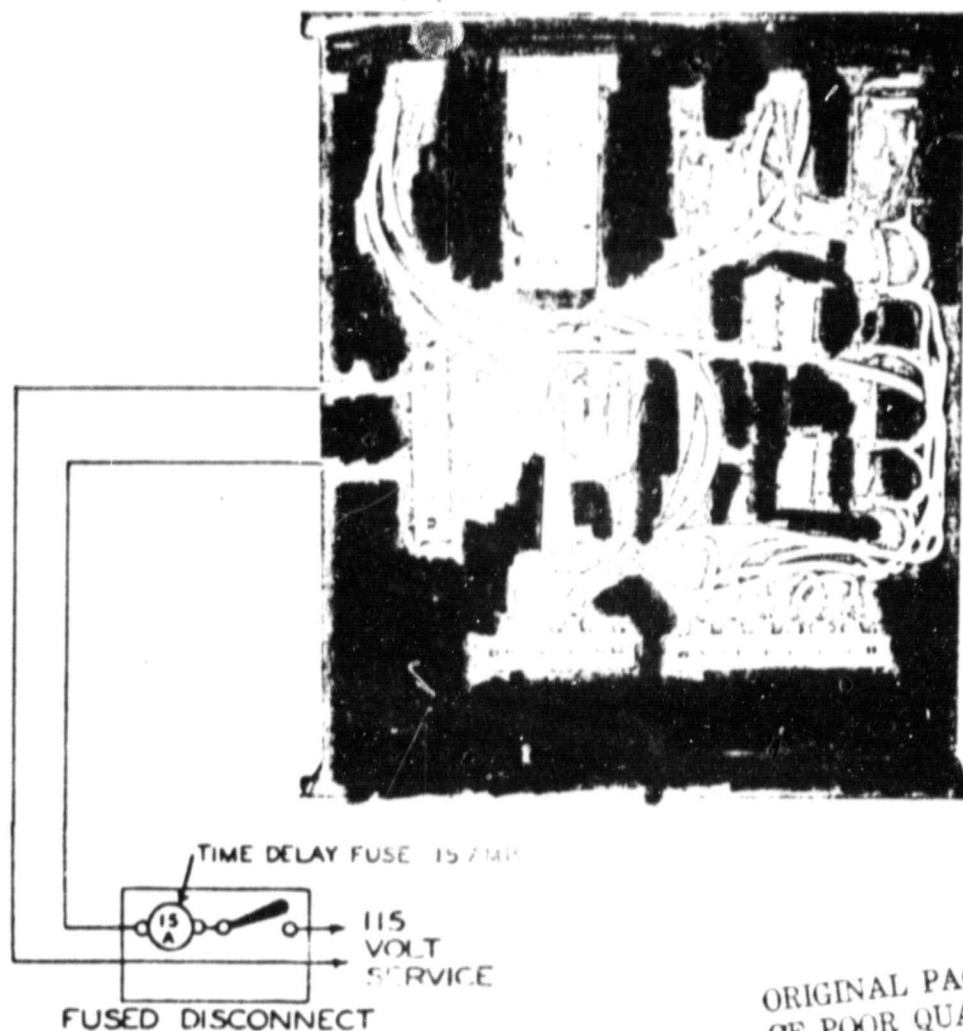
The unit control box contains a 115/24 volt, 50 VA transformer to supply low voltage current to the control system.

The main switches, disconnect switches, fuse holders and fuses are not furnished by Arkla. The fused disconnect should be installed within sight of and not more than 50 feet from the unit.

The recommended line voltage wiring to the unit can be found on III-60-2.

GROUNDING

If type UF underground cable is used, the unit should be grounded by running wiring from an approved electrical ground to a convenient point on the unit's frame. Grounding wire should be attached to the frame in a manner approved by national and/or local Electrical Codes. If conduit is used, it will serve as an adequate ground, providing that the conduit is connected to the building's electrical grounding system.

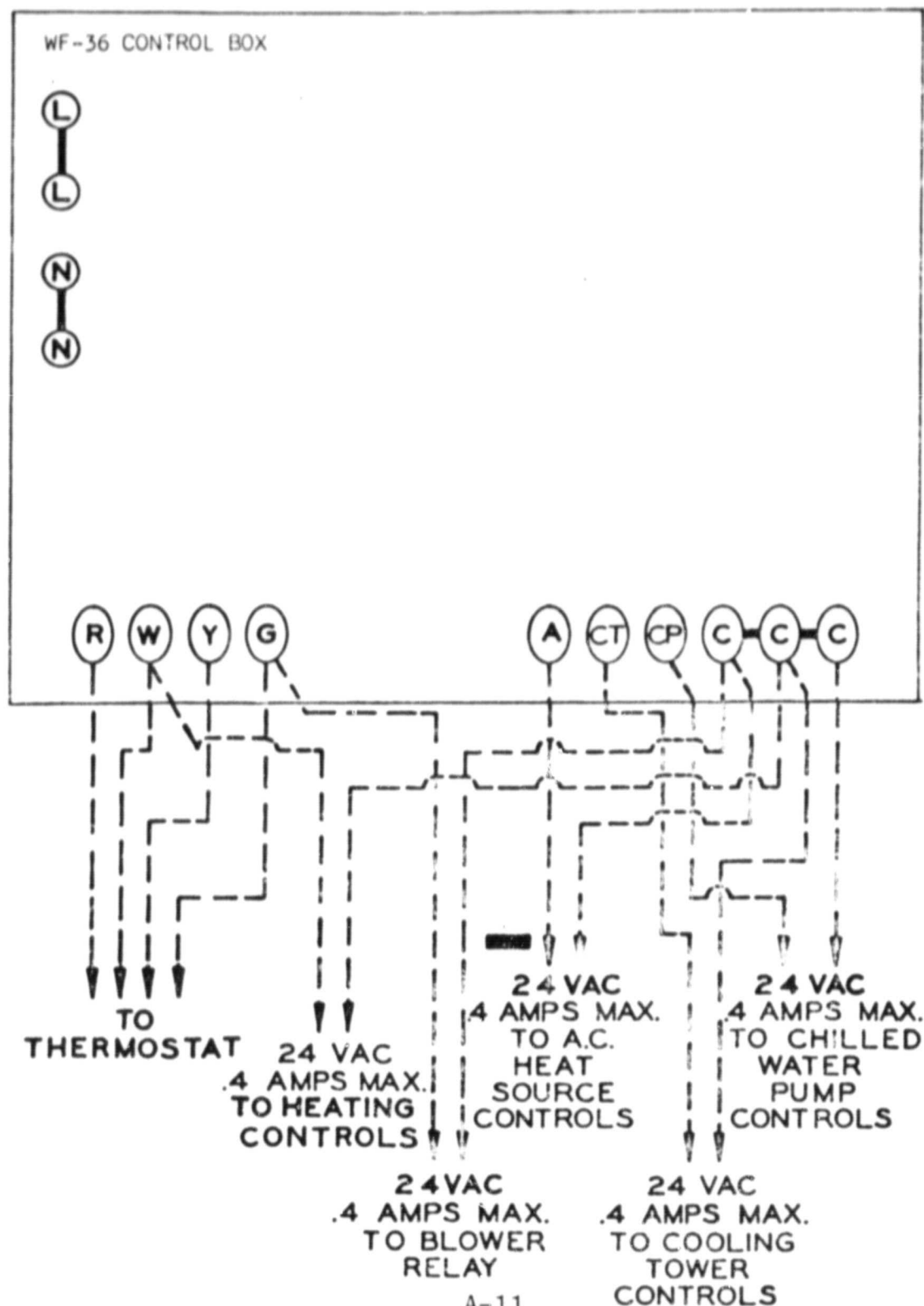


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ELECTRICAL WIRING - LOW VOLTAGE TO CONTROL SYSTEM

The Arkla Solaire unit is wired such as to provide 24 VAC to external relays to control the various pumps and air handler(s) in the heating and air conditioning system. The relays selected should not exceed .4 amp. draw maximum. Wiring from the unit to the relays should be a minimum of 18 gauge.

WF-36



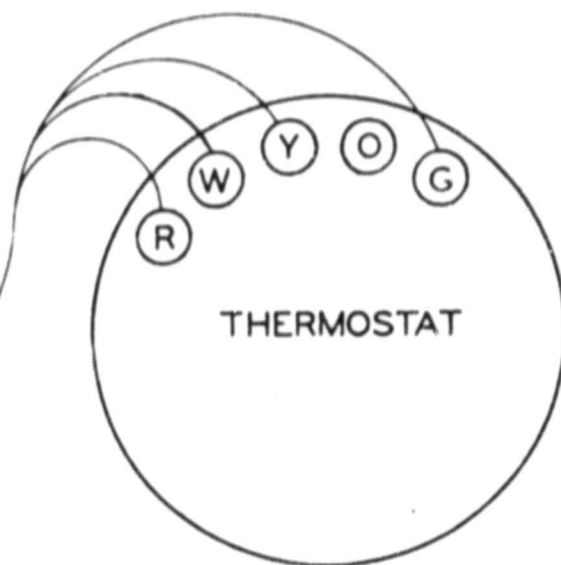
ELECTRICAL WIRING - UNIT TO THERMOSTAT

The wiring from the unit to the thermostat carries 24 volt current. The wires should be a minimum of 18 gauge. Color coded cables carrying the necessary number of wires should be used.

WF-36



4 WIRE #18
THERMOSTAT CABLE



APPENDIX B
Manufacturers Literature
Honeywell Inc., Controls

ENGINEERING DATA FOR

Job Name Kaw Valley State Bank & Trust
Architect Robert S. Slemmons
Engineer Burgess Engineering
Contractor Young's Inc.

SUBMITTED BY HONEYWELL INC.

8401 E. 50 Highway

Kansas City, Missouri 64133

For information regarding this job contact:

Clay Sisk

Refer to job number:

931-77060

Honeywell

The Automation Company

Honeywell

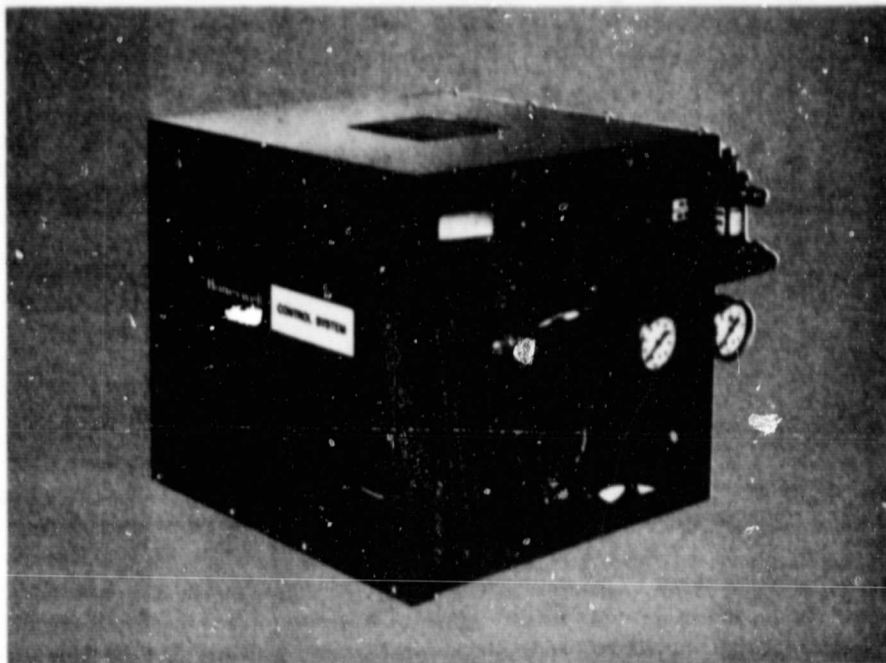
Refrigeration Dryer for Compressed Air

MODEL NUMBER HKN8010B & HKN8010C

General

The HKN8010B and HKN8010C Compressed Air Driers are used to condition air supply systems for pneumatic controls. The HKN8010B and HKN8010C cool the control air and condense and remove oil, water vapor and other contaminants from the control air system.

The condensed oil and water vapor are separated from the air stream and ejected through a drain. The discharged air is filtered, then regulated to a pressure suitable for control devices. The HKN8010B with the PP902A is designed for use in a single pressure system while the HKN8010C uses the PP902B and is designed for use in a two-pressure system requiring two independent, regulated air pressure settings.



Both HKN8010B and HKN8010C include a bypass valve for easy servicing

and signal lights which advise of operating status.

Features

- Bypass valve for easy servicing.
- Power-on status light.
- High temperature alarm light.
- Automatic drain.
- Integral adjustable pressure regulator.
- Submicron final filter in clear plastic housing with replacement element.
- Inlet and outlet pressure gauges for pressure regulator.
- Separately adjustable safety pressure relief valve.
- Simple single anchor mounting.

The HKN8010B and HKN8010C Refrigeration Type Air Driers contain a hermetically sealed, noncycling unit. They have a hot gas bypass control for maintaining continuous operation and constant dew-point control. The heat exchanger is copper "tube-in-tube" coiled and potted in insulating foam.

Specifications

AIR CAPACITY

3 scfm with 100 F (38 C) saturated air inlet (limited by filter capacity).

OUTLET DEWPOINT

+13 F (-12 C) at 18 psi (124 kPa) main pressure [based on 70 to 90 psi (483 to 621 kPa) compressor range].

AMBIENT TEMPERATURE

35 to 110 F (2 to 43 C).

MAXIMUM WORKING PRESSURE

150 psi (1035 kPa).

REFRIGERATION COMPRESSOR

1/6 hp.

VOLTAGE RATING

115v, 60 Hz, single phase.

SHIPPING WEIGHT

65 lbs (29 kg).

MOUNTING

1/2 wall mounted or floor mounted.

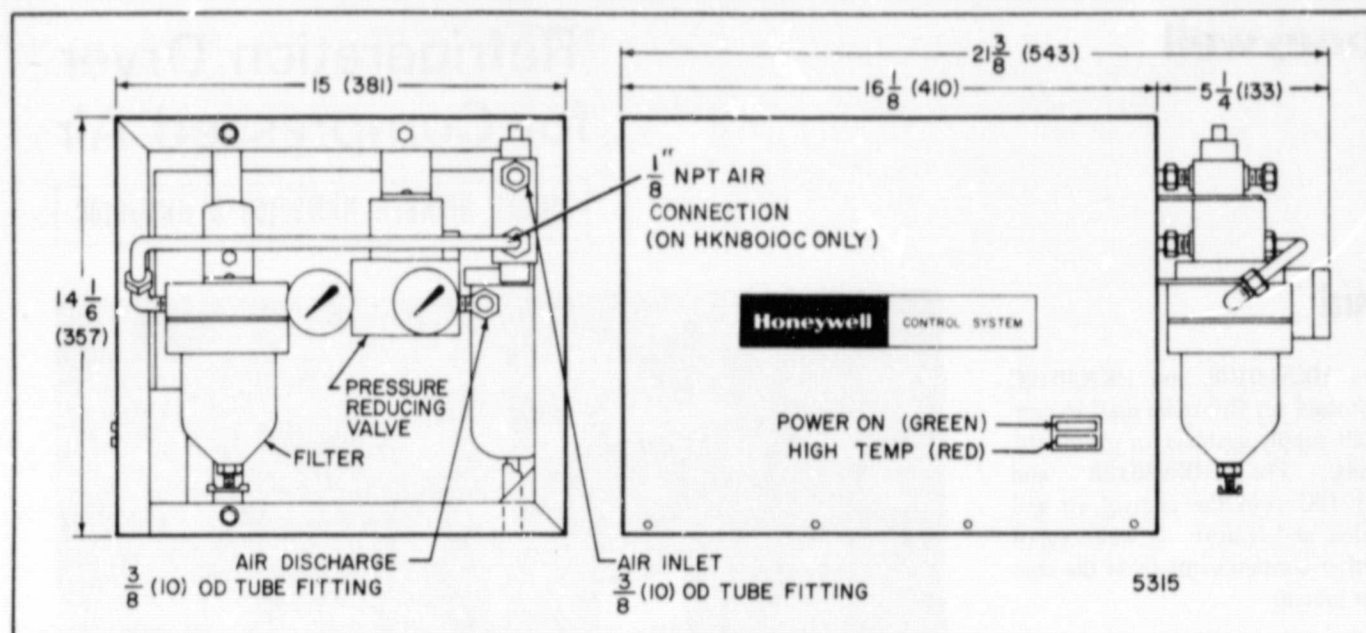


FIG. 1. APPROXIMATE DIMENSIONS IN INCHES (MILLIMETERS)

Typical Operation

Air is cooled in heat exchanger. Separator traps moisture, oil and larger contamination particles and

ejects them through an automatic drain. Submicron filter combines oil and micron size particles. The air then

passes through a pressure regulator. Discharged air is dried, cleaned and regulated to control device requirements.

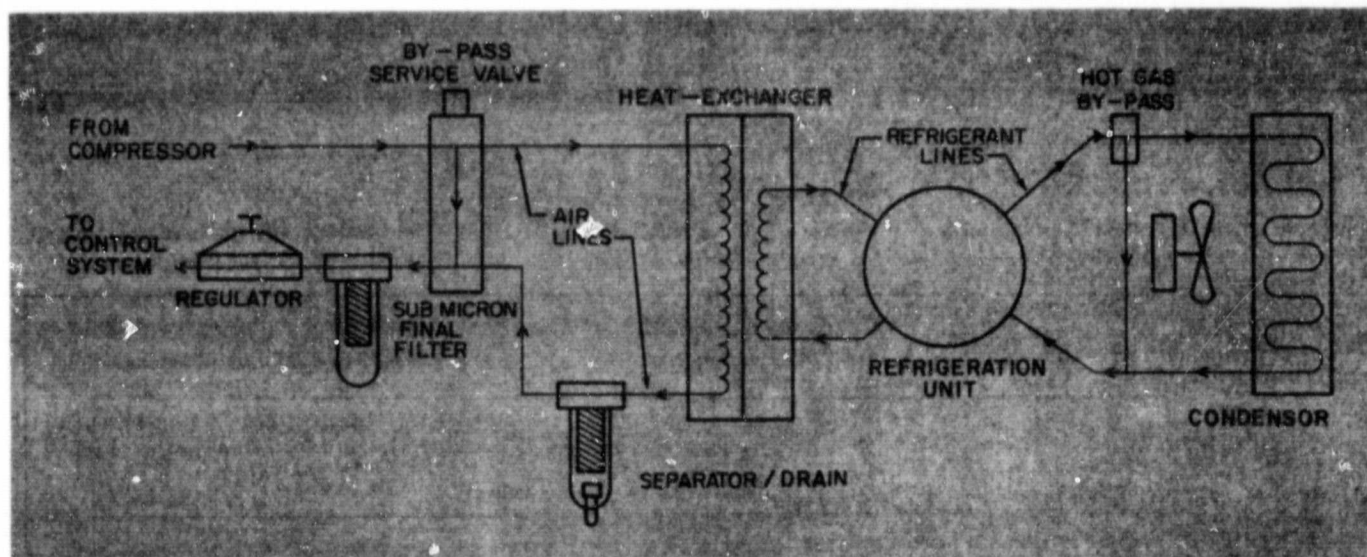


FIG. 2. AIR FLOW SCHEMATIC DIAGRAM FOR HKN8010 REFRIGERATION TYPE AIR DRYER

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MAINTENANCE AND REPAIR

L480B and L480G TEMPERATURE CONTROLLERS

INTRODUCTION

These instructions cover general maintenance, disassembly and repair for the L480B and L480G Temperature Controllers. A complete parts list and exploded view drawings are included to facilitate repair. The parts and assemblies are identified completely by part number and description. For ordering information, see the note following Fig. 3.

NOTE: Prices may be obtained from our local branch office. Prices and availability are subject to change without notice.

No special tools are required to maintain this device.

MAINTENANCE

INSPECTION AND CLEANING

The cover of the temperature controller must be in place at all times to protect internal components from dust, dirt and physical damage. After initial installation, the only maintenance necessary is occasional inspection and cleaning.

CAUTION: Be sure to disconnect the power source before removing the controller cover to work on the internal components.

1. Remove the cover of the controller and inspect for any internal or external damage.
2. Remove accumulated dirt or dust by using a soft brush or air hose.
3. If internal inspection reveals any damaged parts, remove the controller and disassemble.

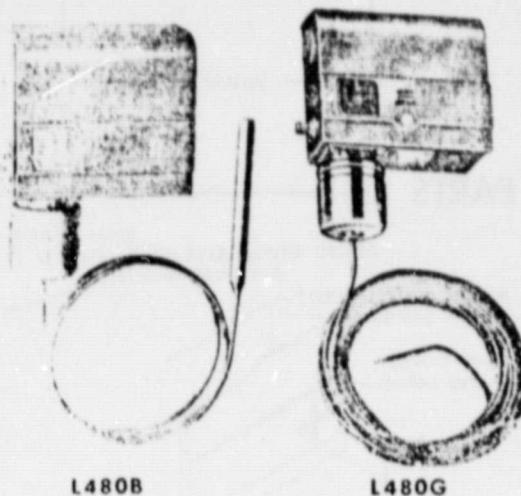
CAUTION: Use special care when using solvents. Avoid prolonged inhalation and/or contact with the skin. Careless handling can result in permanent damage to the respiratory system and skin tissue.

4. Clean disassembled parts in the solvent listed in Table 1. Order replacement parts from the exploded view drawings and parts list in this form.

5. Reassemble the controller, coating all pivot points and screw threads with the lubricant listed in Table 1.

Table 1.

MATERIAL	APPLICATION
Inhibited 1,1,1-Trichloroethane such as Chlorothene or Vythene	Obtain locally—use to soften grease and dirt which cannot be easily removed.
Lubricant—Multi-Purpose Grease (Honeywell part number 802771—4 oz. tube)	Obtain from Honeywell branch office—lubricate screw threads to prevent rust and corrosion.



OPERATIONAL CHECK

After routine maintenance, return the system to normal operation. Place an accurate thermometer next to the sensing element, or provide other necessary means to measure the temperature of the controlled medium. When a stable temperature is reached, check the controller operation as follows:

For L480G, L480B1098 and L480B1106 Controllers.

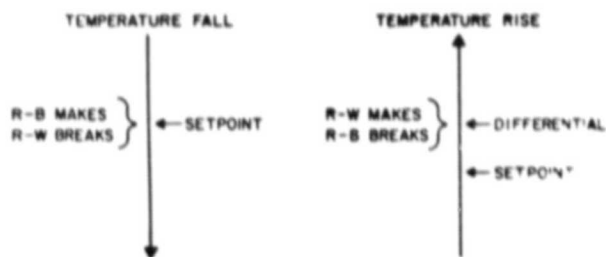
These controllers are designed for freeze-up protection and are calibrated to the break of R-W switch contacts at the lowest temperature sensed by any one foot portion of the 20 foot temperature sensing element.

Turn the adjustment knob to the lowest setting. Slowly turn the adjustment knob toward the high scale setting. This will simulate a temperature fall at the sensing element. The R-W switch contacts will break at the indicated thermometer temperature and the cooling equipment will stop. The scale reading should correspond to the measured temperature, unless air-flow stratification causes some portion of the element to respond to a lower temperature (See Fig. 1).

For other L480B Controllers.

Turn the adjustment knob to the lowest setting. Slowly turn the adjustment knob toward the high scale setting. This will simulate a temperature fall (call for heat) at the sensing element. The R-B contacts will make and the heating equipment will start. Note the scale setting at this point. It should correspond to the thermometer reading at the sensing element.

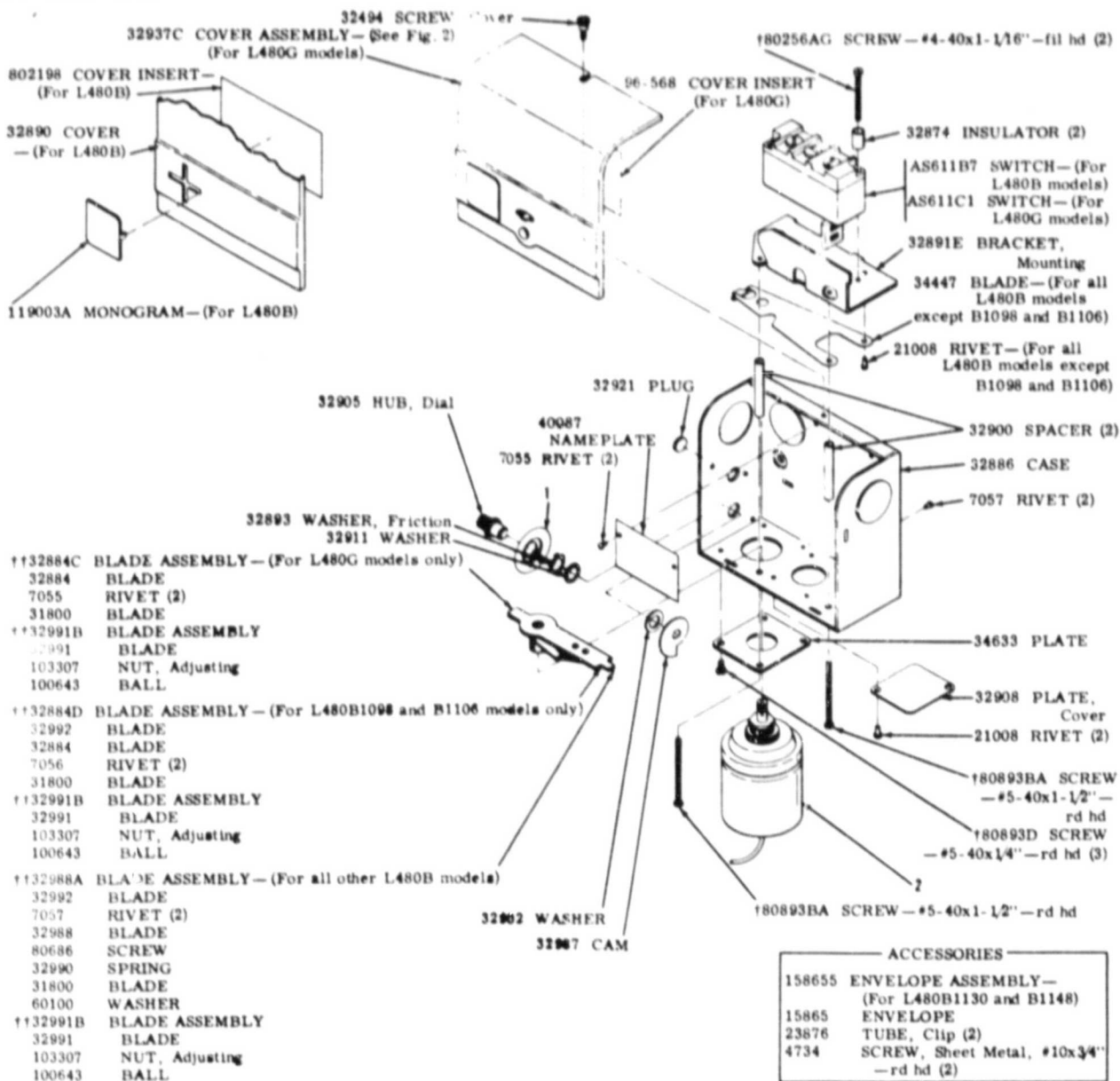
Reset the controller to a normal setpoint and allow the system to settle out. Then turn the adjustment knob to the highest setting. Slowly turn the adjustment knob toward the lowest setting. This will simulate a temperature rise (call for cooling) at the sensing element. The R-B contacts will break. Note the scale setting at this point. It should correspond to the thermometer's reading plus the set differential of the controller (See Fig. 1).



NOTE: The L480G is a manual unit controller and must be reset each time the equipment stops.

Fig. 1—Typical Operation.

PARTS LIST



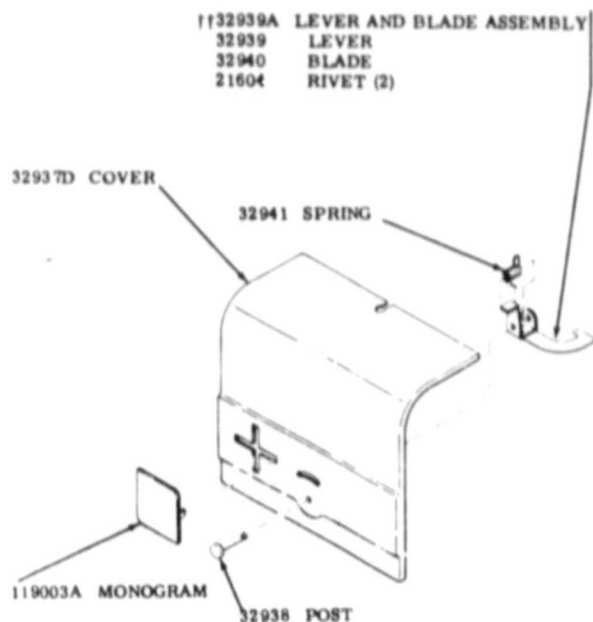
†Standard parts (screws, washers, electrical components, etc.) should be obtained locally when possible. Component values are subject to change without notice. Always use exact replacement parts when making repairs.

††Because the component parts of this assembly are staked or require a special assembly process, it is recommended that a complete replacement assembly be ordered.

Fig. 2—L480B and L480G Temperature Controllers.

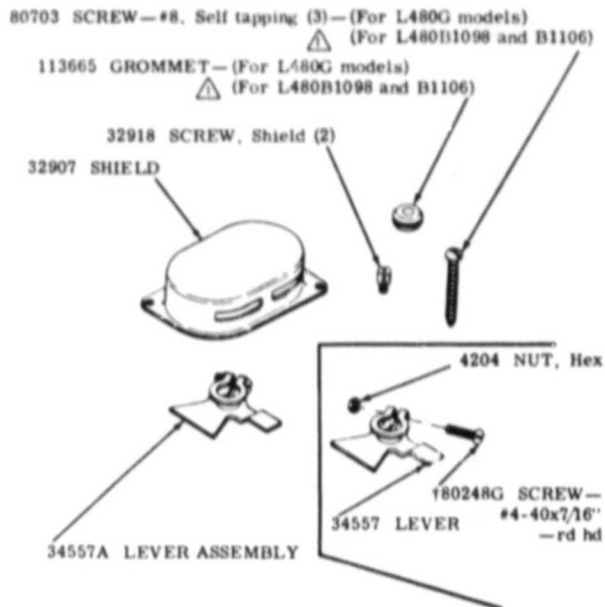
Parts List for Fig. 2

KEY	PART NO.	DESCRIPTION	MODELS	
			L480B	L480G
1	32889B	DIAL—(50°F to -10°F)	1007 1015	
1	32889C	DIAL—(-10°F to +20°F)	1023 1031	
1	32889E	DIAL—(+30°F to +70°F)	1114 1122 1130 1148	
1	32889F	DIAL—(+65°F to +95°F)	1171 1189 1197	
1	32889G	DIAL—(0°F to +50°F)	1049 1056 1064 1205	
1	32889L	DIAL—(+30°F to +60°F)	1098	1002
1	32889J	DIAL—(-15°C to 0°C)	1072 1080	
1	32889K	DIAL—(0°C to +20°C)	1155 1163	
1	32889M	DIAL—(0°C to +15°C)	1106	1010
2	32199ACKA	†† ELEMENT ASSEMBLY—(-50°F to -10°F) 5' long, Remote Bulb Type	1007	
2	32199DCKA	†† ELEMENT ASSEMBLY—(-50°F to -10°F) 20' long, Remote Bulb Type	1015	
2	32199ACPB	†† ELEMENT ASSEMBLY—(-20°F to +20°F) 5' long, Remote Bulb Type	1023	
2	32199DCPB	†† ELEMENT ASSEMBLY—(-20°F to +20°F) 20' long, Remote Bulb Type	1031	
2	32199ACMF	†† ELEMENT ASSEMBLY—(0°F to +50°F) 5' long, Remote Bulb Type —(-17°F to +10°C) 5' long, Remote Bulb Type	1049 1072	
2	32199DCMF	†† ELEMENT ASSEMBLY—(0°F to +50°F) 20' long, Remote Bulb Type —(-17°F to +10°C) 20' long, Remote Bulb Type	1056 1080	
2	32199FCMF	†† ELEMENT ASSEMBLY—(0°F to +50°F) 30' long, Remote Bulb Type	1064	
2	32199NCSD	†† ELEMENT ASSEMBLY—(-30°F to +70°F) 5' long, Remote Bulb Type	1130	
2	32199SCSD	†† ELEMENT ASSEMBLY—(+30°F to +70°F) 20' long, Remote Bulb Type	1148	
2	32199ACBE	†† ELEMENT ASSEMBLY—(+65°F to +95°F) 5' long, Remote Bulb Type	1171	
2	32199DCBE	†† ELEMENT ASSEMBLY—(+65°F to +95°F) 20' long, Remote Bulb Type	1189	
2	32199FCBE	†† ELEMENT ASSEMBLY—(+65°F to +95°F) 5' long, Remote Bulb Type	1197	
2	32199ACSD	†† ELEMENT ASSEMBLY—(+30°F to +70°F) 5' long, Remote Bulb Type —(0°F to +20°C) 5' long, Remote Bulb Type	1114 1155	
2	32199DCSD	†† ELEMENT ASSEMBLY—(0°F to +20°C) 20' long, Remote Bulb Type	1163	
2	32199DCSD	†† ELEMENT ASSEMBLY—(+30°F to +70°F) 20' long, Remote Bulb Type	1122	
2	32199DCSD	†† ELEMENT ASSEMBLY—(+30°F to +60°F) 20' 1/8" OD Capillary Type —(0°F to +15°C) 20' 1/8" OD Capillary Type	1098 1106	1002 1010



††Because the component parts of this assembly require special assembly processes, it is recommended that a complete replacement assembly be ordered.

Fig. 3—32937C Cover Assembly.



△ Included in 407BKH Envelope Assembly only.

†Standard parts (screws, washers, electrical components, etc.) should be obtained locally when possible. Component values are subject to change without notice. Always use exact replacement parts when making repairs.

Fig. 4—4074FF and 4074BKH Envelope Assembly.

NOTE: Please order by Part No. and Description. Also, give the complete Order Specification number of the Temperature Controller. The number is stamped inside the cover. In some cases it may be necessary to return the entire device to our factory for complete repair and reconditioning. Order from Honeywell, Golden Valley Plant, 1885 Douglas Drive North, Minneapolis, Minnesota 55422 (In Canada: Honeywell Controls Limited, Vanderhoof Avenue, Leaside, Toronto 17, Ontario). Prices may be obtained from our local branch.

Mechanical devices must be serviced periodically if they are expected to give continued satisfactory performance, and controls are not an exception. How accurate and how troublefree your control system will be in the years to come depends largely on the maintenance given it. For best results, all devices in your system should be serviced at one time.

Time and trouble can be saved by arranging with Honeywell for a maintenance agreement which will guarantee expert, economical care, and insure maximum life and efficiency from your system.

Honeywell

AQUASTAT CONTROLLERS ARE IMMERSION TYPE DEVICES FOR LIMITING OR REGULATING THE TEMPERATURE OF LIQUIDS IN BOILERS, STORAGE TANKS, AND OTHER APPLICATIONS WHERE TEMPERATURE CONTROL OF LIQUIDS IS REQUIRED. AS THE TEMPERATURE OF THE CONTROLLED MEDIUM RISES TO THE SET POINT, EXPANSION OF THE FLUID IN THE SENSING ELEMENT OPERATES THE INTERNAL SWITCH OR SWITCHES.

☐ The L4006, 7, and 8 provide spst switching for high or low limit control of a burner.

☐ The L4006G model has two spst switches that make and break in sequence to provide boiler sequencing.

☐ The L6006 and 8 provide spdt switching for low limit and circulator control.

☐ Models which break contact on a temperature rise to the set point are calibrated for high limit use. They are also suitable for low limit control if a separate high limit control is used.

☐ Ambient compensated models are available to prevent control-point shift caused by temperature fluctuation at the case.

☐ Visible control point scale and external adjustment screw permit easy setting.

☐ Models are available for either horizontal or vertical insertion of the sensing element. The sensing element may be directly immersed or placed in an immersion well.

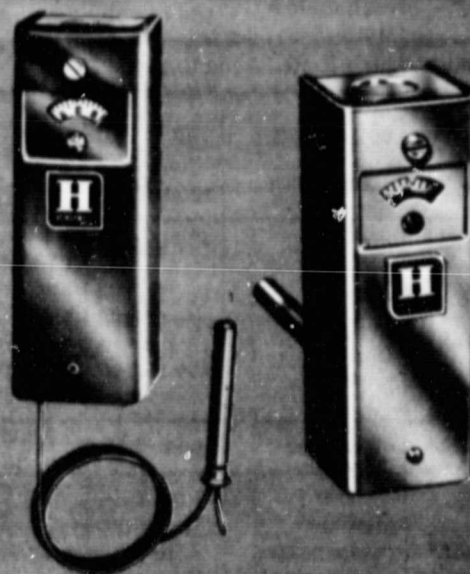
☐ Remote bulb models are available if the controller must be mounted at a location away from the sensing element.

☐ Remote bulb models may also be used to sense air temperature in ducts and in outside air sensing applications.

☐ Totally enclosed Micro Switch snap-acting switches are used in all models.

S.K.
7-75

AQUASTAT CONTROLLERS



L4006,7,8; L6006,8

Residential Div. Form Number

60-2104 1

SPECIFICATIONS

SPST MODELS:

MODEL	APPLICATION	RANGE (F)	MIDSCALE DIFFERENTIAL (F)	INSERTION ^a	SWITCHING ON TEMP. RISE	AVAILABLE OPTIONS
L4006A	high or low limit	40 to 180 or 100 to 240	2 or 5 fixed or 5 to 30 adj.	horizontal	breaks	Tradeline models which include well and tube of heat conductive compound. Plastic shield for covering well in water heater applications. 3/4 in. NPT brass spud. Centigrade scale markings. Factory set stops at 160 F, 185 F, 190 F, 200 F, or 220 F. Dial marked WARM, NORMAL, HOT. Insulation depths of 1-1/2, 3, or 5 inches.
L4006B	circulator	40 to 180 or 100 to 240	5 fixed or 5 to 30 adj.	horizontal	makes	3 inch insulation depth. 3/4 inch NPT brass spud.
L4006C	high or low limit	100 to 240	2 or 5 fixed	horizontal direct	breaks	10 in. element. Factory set stop at 205 F.
L4006Eb	high limit	110 to 250	manual reset	horizontal or vertical	breaks	3/4 in. NPT brass spud. 3 in. insulation depth.
L4006G	sequencing	100 to 240	5 fixed interstage 3-10 F adj.	horizontal or vertical	breaks two switches	—
L4007A	high or low limit	100 to 240	2 or 5 fixed, 5 to 30 adj.	vertical	breaks	Centigrade scale markings.
L4007B	circulator	100 to 240	5 fixed or 5 to 30 adj.	vertical	makes	—
L4008A ^a	high or low limit	40 to 180 or 100 to 240	2 or 5 fixed, 5 to 30 adj.	remote bulb	breaks	5 ft.6 in., 8 ft.6 in. or 10 ft. remote capillary. Factory set scale stop at 120 or 200 F. External adjusting knob. Centigrade scale markings.
L4008B ^a	circulator	100 to 240	5 fixed or 5 to 30 adj.	remote bulb	makes	8 ft.6 in. capillary.
L4008C ^a	ambient compensated high limit	0 to 70 or 40 to 180	2 or 5 fixed	remote bulb	breaks	7 ft.6 in., 20 ft. capillary or fast response element. External adj. knob. 150 va rating at 120, 240v ac. High limit stamped on case scale lock.

L4008 models continued on page 3

^aCopper well or fitting is supplied with all models except remote bulb type. When ordering, specify boiler tapping size (1/2 or 3/4 inch) and insulation depth.

^bManual reset (trip-free)—Switch breaks circuit and locks out when controlled medium reaches set point. Controlled temperature must drop 20 degrees below set point before contacts can be manually reset.

ORDERING INFORMATION

WHEN ORDERING REFER TO THE TRADELINE CATALOG OR PRICE SHEET FOR COMPLETE ORDERING SPECIFICATION NUMBER, OR...

SPECIFY —

1. MODEL NUMBER.
2. OPERATING RANGE.
3. DIFFERENTIAL; ADJUSTABLE, NONADJUSTABLE, OR MANUAL RESET.
4. CAPILLARY LENGTH.
5. BOILER TAPPING AND INSULATION DEPTH.
6. ACCESSORIES.

ORDER FROM —

1. YOUR USUAL SOURCE, OR
2. HONEYWELL
1885 DOUGLAS DRIVE, NORTH
MINNEAPOLIS, MINNESOTA 55422
(IN CANADA — HONEYWELL CONTROLS LIMITED
740 ELLESMERE ROAD
SCARBOROUGH, ONTARIO)

SPST MODELS CONTINUED:

MODEL	APPLICATION	RANGE (F)	MIDSCALE DIFFERENTIAL (F)	INSERTION ^a	SWITCHING ON TEMP. RISE	AVAILABLE OPTIONS
L4008D ^a	ambient compensated circulator	0 to 70 or 40 to 180	2 or 5 fixed	remote bulb	makes	Tradeline model available. Centigrade scale markings. Hot tinned 8 ft. capillary. Electrical rating: 2.3 amp at 120-240v ac, full load. Fast response, 10 ft. armored capillary with 3 ft. bulb. External adjustment knob. Factory set scale stops at 120, 220, or 250 F. Plastic shield for covering well in water heater applications.
L4008E ^{ab}	high limit	40 to 80 or 110 to 290	manual reset	remote bulb	breaks	Factory set scale stop at 250 F. 8 ft. 6 in. capillary.
L4008J ^a	high limit	100 to 240	5 fixed	remote bulb	breaks	All models less case and cover. 18 in. capillary and 1/2 in. well assy. Factory set scale stop at 220 F.
L4008K ^a	circulator	40 to 180	5 fixed	remote bulb	makes	All models less cover.

SPDT MODELS:

MODEL	APPLICATION	RANGE (F)	MIDSCALE DIFFERENTIAL (F)	INSERTION ^a	AVAILABLE OPTIONS
L6006A ^a	circulator and low limit or high limit	100 to 240 or 110 to 290	5 fixed or 5 to 30 adj.	horizontal	Tradeline model which includes well adapter and tube of heat conductive compound. 3/4 in. NPT brass spud. 3 in. insulation depth. Horizontal or vertical mount available on same models.
L6006B	circulator and low limit or high limit	100 to 240	5 fixed or 5 to 30 adj.	horizontal	3/4 in. brass bulb compression fitting.
L6008A ^a	circulator and low limit cooling	100 to 240 -30 to 70	5 fixed or 5 or 30 adj.	remote bulb	Tradeline model with 5 ft. capillary. Range of -30 to 70 F. Centigrade scale markings. Without cover.
L6008C ^a	dual fuel changeover	0 to 70 40 to 180	2 or 5 fixed	remote bulb. May be duct mounted.	Tradeline model. 150 va switch rating. Centigrade scale markings. 7 ft. 6 in. armored capillary. External adjustment knob. Lock type cover. 20 ft. element. Averaging element.
L6008E ^a	ambient compensated	40 to 180	5 fixed	remote bulb	All models less enclosure. Front mounted.

^aCopper well or fitting is supplied with all models except remote bulb type. When ordering, specify boiler tapping size (1/2 or 3/4 inch) and insulation depth.

^bManual reset (trip-free)—Switch breaks circuit and locks out when controlled medium reaches set point. Controlled temperature must drop 20 degrees below set point before contacts can be manually reset.

NOTE: The following specifications are standard. Variances, available as options, are noted in the preceding table.

ELECTRICAL RATING (AMPS):

Models with 2 F fixed differential—

	120v ac	240v ac
FULL LOAD	2.6	1.3
LOCKED ROTOR	15.6	7.8

Models with 5 F differential—

	120v ac	240v ac
FULL LOAD	8	5.1
LOCKED ROTOR	48	30.6
INDUCTIVE CURRENT	.25 at 1/4 to 12v dc	

PRESSURE RATING:

Capillary bulb (direct immersion)—200 psi.
Immersion well—255 psi.

SENSING BULB MATERIAL: Copper.

SENSING BULB FILL: Liquid. Toluene or Silicone.

CAPILLARY LENGTH (including bulb): Remote bulb models—60 inches.

SENSING BULB DIMENSIONS (inches): 2-7/8 long, 3/8 diameter.

INSERTION DEPTH: 3-3/8 inches.

INSULATION: Brass. 1-1/2 or 3 inches. Specify when ordering.

PROVISION FOR WIRING: Screw terminals.

MOUNTING: Horizontal and vertical models mount directly to an immersion well installed in a boiler fitting. Remote bulb models have 3 mounting holes rear of case for screw mounting to a vertical surface.

FINISH: Gray.

INSTALLATION DIMENSIONS: See Figs. 1 and 2.

IMMERSION WELL DIMENSIONS: See Fig. 3.

BOILER FITTING AND BULB DIMENSIONS: See Fig. 4.

ACCESSORIES:

Weatherproof enclosure—Q615.

Immersion wells—

Copper, 1/2 NPT, 1-1/2 inch insulation—Part No. 121371A.

Copper, 1/2 NPT, 3 inch insulation—Part No. 121371L.

Copper, 3/4 NPT, 1-1/2 inch insulation—Part No. 121371B.

Copper, 3/4 NPT, 3 inch insulation—Part No. 121371M.

Copper, 3/4 NPT, 1-1/2 inch insulation, plastic sleeve—Part No. 121371K.

Copper, 3/4 NPT, 3 inch insulation, plastic sleeve—Part No. 121371N.

Stainless steel, 1/2 NPT, 1-1/2 inch insulation—Part No. 121371E.

Stainless steel, 3/4 NPT, 1-1/2 inch insulation—Part No. 121371F.

Bulb Compression Fittings (see Fig. 6)—

Brass, 1/2 NPT plug. 1-1/2 inch insulation—Part No. 104486B.

Brass, 3/4 NPT plug. 1-1/2 inch insulation—Part No. 104486C.

Capillary Compression Fittings (see Fig. 7)—

Copper, 1/2 NPT plug. 1-1/2 inch insulation—Part No. 104484C.

Copper, 3/4 NPT plug. 1-1/2 inch insulation—Part No. 104484B.

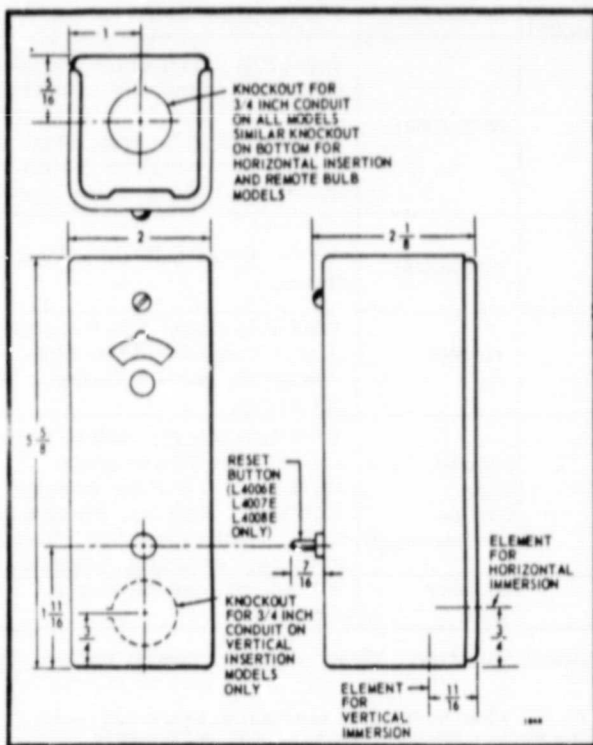


FIG. 1—INSTALLATION DIMENSIONS.

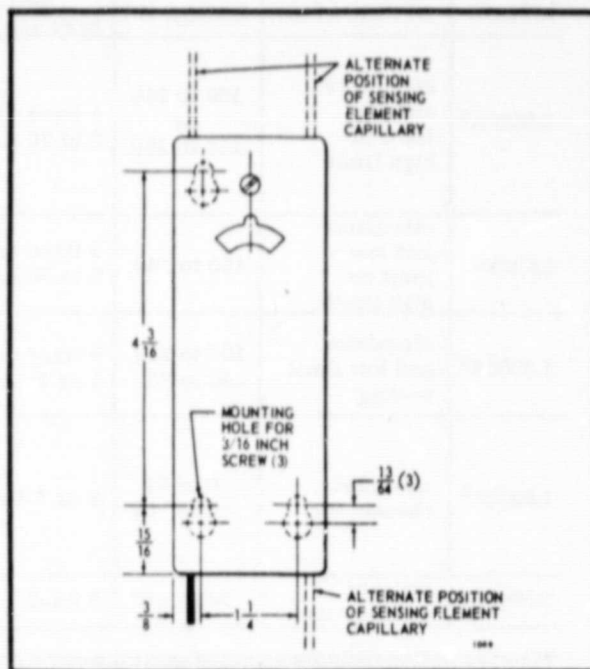


FIG. 2—INSTALLATION DIMENSIONS FOR REMOTE BULB MODELS. OTHER DIMENSIONS SAME AS FIG. 1.

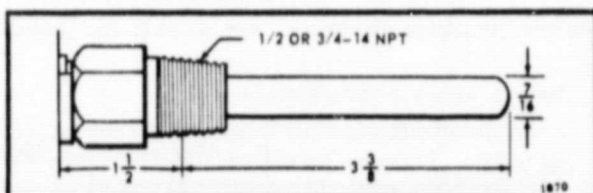


FIG. 3—IMMERSION WELL DIMENSIONS FOR ALL MODELS EXCEPT L4006C, L4007D, AND L6006B.

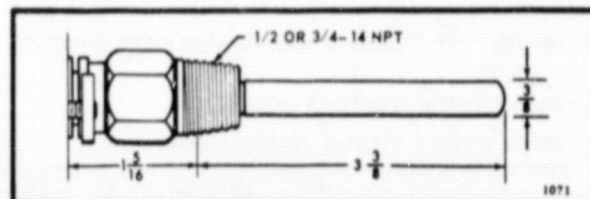


FIG. 4—BOILER FITTING AND BULB DIMENSIONS FOR L4006C, L4007D, AND L6006B.

INSTALLATION

The manufacturer usually provides a tapping for insertion of the controller's sensing element. This tapping is located at a point where typical water temperature can be measured. Depending on model, the element is inserted in an immersion well, through a boiler fitting, or directly immersed.

Installation should be made by a qualified serviceman. Follow the instructions furnished by the system manufacturer, if available. Otherwise, refer to appropriate procedure listed below.

IMPORTANT

Controller may be used with or without immersion well. Well, if used, must fit sensing bulb snugly for good thermal response. Insert bulb until it rests against bottom of well, then hold it there while tightening the tubing clamp.

MOUNTING REMOTE BULB MODELS

The remote temperature-sensing bulb can either be installed in an immersion well (Fig. 5) that extends into the boiler or tank, or it can be directly immersed in the liquid. For installations not using a well, secure the remote bulb with a bulb compression fitting (Fig. 6), or capillary compression fitting (Fig. 7).

Well, bulb compression fitting or capillary compression fitting must be ordered separately. Sizes available: 1/2 in., 3/4 in. NPT spud. Well, if used, must fit sensing bulb snugly for good thermal response. Insert bulb until it rests against bottom of well, then hold it there while tightening the tubing clamp. (See Fig. 5.)

The boiler manufacturer generally provides a tapping for the insertion of the Aquastat controller's sensing element. This tapping should be located at a point where typical water temperature can be measured. The bulb or protecting immersion well must never be located close to a hot or cold water inlet or a steam coil.

If the system is filled, drain system to a point below the boiler tapping, or wherever the sensing bulb is to be installed.

The bulb can also be installed in the supply line of an indirect water heater, in the direct water heater itself, or in the feed riser, about 6 in. above the boiler. If the riser is valved, the bulb can be installed between the boiler and the valve.

NOTE: Avoid making sharp bends or kinks in the capillary. Bends should be no sharper than 1 inch radius.

After installing, carefully coil excess capillary at the bottom of the controller case.

IMMERSION WELL MOUNTING

1. Screw the well into the boiler, tank, or pipe tapping.
2. Insert bulb in well, pushing tubing until bulb bottoms in well.

3. Attach retainer clamp to end of well spud. Loosen draw nut and spread jaws of clamp with screwdriver if necessary.

4. With retainer clamp attached to well spud (be sure jaws of clamp hook over ridge at end of spud, as shown at points "A"), adjust tubing to fit through retainer clamp groove, as shown at point "B."

5. Tighten draw nut so that retainer clamp is firmly attached to well spud and tubing is held securely in place.

CAUTION

Do not secure draw nut so tightly that retainer clamp could collapse tubing.

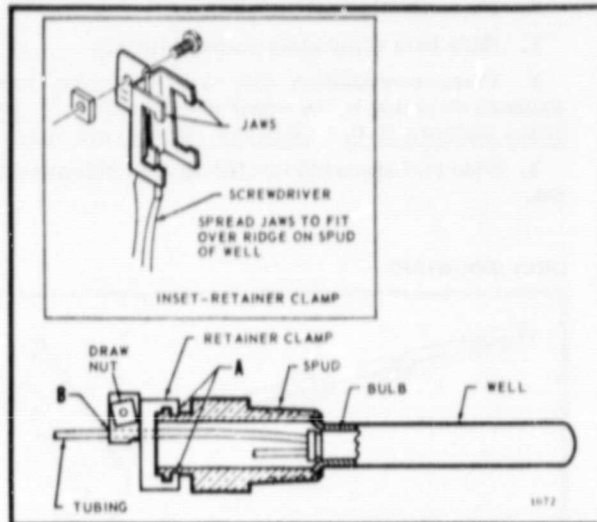


FIG. 5—IMMERSION WELL FITTING.

MOUNTING WITH BULB COMPRESSION FITTING

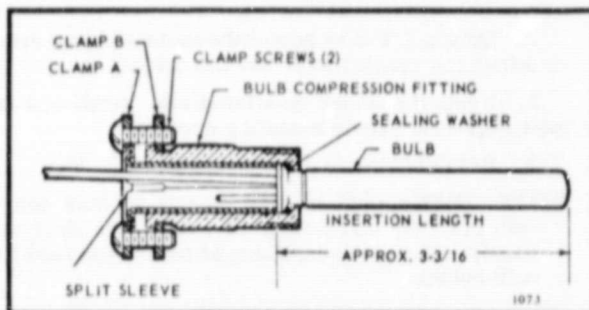


FIG. 6—BULB COMPRESSION FITTING. USE WITH MODEL L4008A, B, E, J, OR L6008A.

1. Screw the fitting into boiler or pipe tapping.
2. Slide sealing washer onto bulb.
3. Insert bulb into boiler fitting until bulb bottoms.
4. Slide split sleeve into fitting.
5. Place clamps A and B on assembly so that sleeve is drawn into fitting when screws are tightened. Note: make sure that nub on clamp A engages space between sleeve and clamp.
6. Tighten clamp screws evenly.

MOUNTING WITH CAPILLARY COMPRESSION FITTING

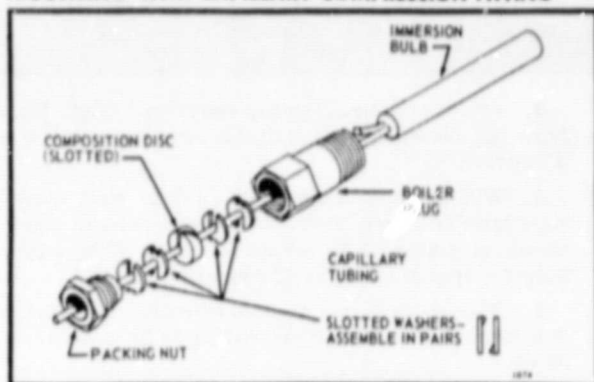


FIG. 7—CAPILLARY COMPRESSION FITTING. USE WITH MODEL L4008C,D,K, OR L6008C,E.

1. Screw fitting into boiler or pipe tapping.
2. Place packing nut on tubing.
3. Slide bulb completely through fitting.
4. Place composition disc and 4 slotted brass washers on tubing in the order shown in Fig. 7. Turn brass washers so that slots are 180 degrees apart.
5. Slide seal assembly into fitting and tighten packing nut.

DUCT MOUNTING

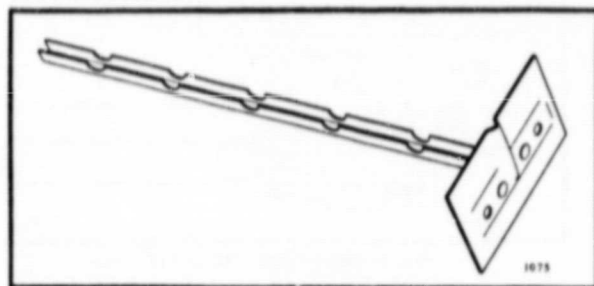


FIG. 8—BULB SUPPORT.

1. Drill a 3/4 inch hole in the duct wall large enough to admit the sensing bulb into the holder.
2. Using the holder as a template, mark and drill holes for bulb holder mounting screws.
3. Break holder to desired length (Fig. 9).

NOTE: Holder must be long enough to hold sensing bulb in freely circulating air away from duct wall. Neatly coil excess capillary at controller case or at bulb holder.

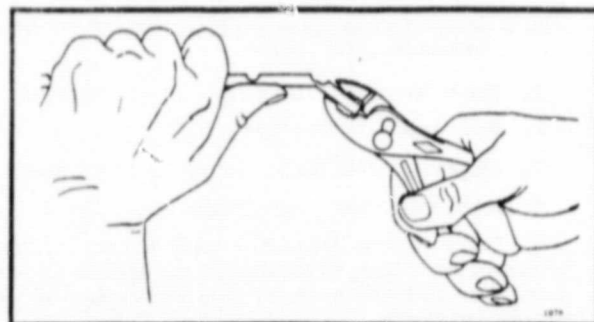


FIG. 9—REMOVING EXCESS BULB SUPPORT.

4. Place capillary in bulb holder channel. Pinch top edges of holder together at each segment (Fig. 10).

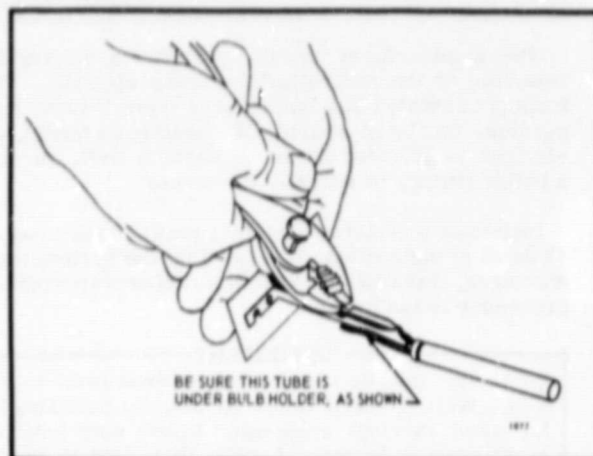


FIG. 10—SECURING CAPILLARY IN BULB HOLDER.

5. Insert bulb holder into controlled area through hole prepared in step 1 above.
6. Fasten bulb holder to duct wall with screws furnished.

MOUNTING DIRECT IMMERSION MODELS

FOR MODELS USING AN IMMERSION WELL

The well of the Aquastat controller must always be exposed to circulation of the medium under control, but must never be located close to a hot or cold inlet or steam coil. Where the tapping is on the side of the boiler, use an Aquastat controller with horizontal well. Where the tapping is on top of the boiler, use a model with a vertical well.

INSTALLING THE IMMERSION WELL

On existing installations, shut off the power and remove the old control. If the old immersion well appears suitable, and if the adapter clamp on the Aquastat controller fits the old well spud, the well need not be replaced.

1. If the system is filled, drain system to a point below the boiler tapping.
2. Remove plug (or old well) from boiler tapping.
3. Install the No. 121371 Immersion Well included with the controller. If boiler tapping is greater than 1/2 inch a reduction fitting must be used to adapt the boiler opening to the 1/2 inch threads that are standard with the well or fitting. Fittings with 3/4 inch threads are also available.
4. Fill the system. Make sure that the well is screwed in tightly enough to prevent leakage. Do NOT tighten or apply force to case after controller is secured to well.

INSTALLATION OF SENSING BULB IN IMMERSION WELL

- Loosen screw (at top case, above scale-setting), and remove cover. Loosen two screws that secure adapter clamp. See Fig. 11.
- Insert the sensing element into the immersion well.
- Fasten the case of the Aquastat controller to the well with the adapter clamp. Make certain that the clamp is properly positioned over the groove of the well spud. Also be sure the flange at the opening of the well fits snugly into the opening of the case. The sensing element bulb must bottom in the well.

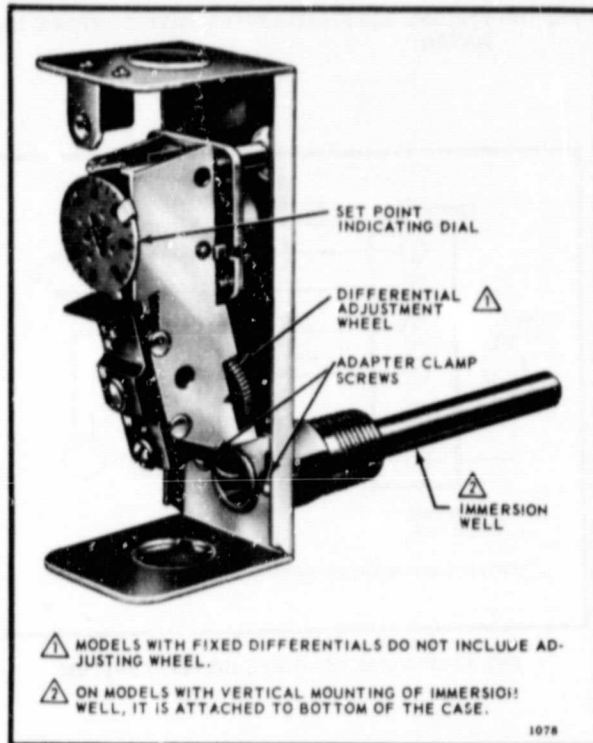


FIG. 11—INTERNAL VIEW OF L6006A.

MODELS DESIGNED FOR DIRECT IMMERSION (WITHOUT WELL)

Some models, which provide direct immersion of the sensing element into the boiler, include a No. 104486 bulb compression fitting assembly instead of an immersion well. Install fitting in boiler tapping. Be sure sealing washer is in place as shown in Fig. 12. Make sure that spud of bulb compression fitting is screwed in tightly enough to prevent leaking. Insert immersion bulb (sensing element) through bulb compression fitting. Adjust the adapter clamp so that it fits over the groove at the opening of the bulb compression fitting. Tighten adapter clamp screws so that Aquastat controller is firmly attached to bulb compression fitting.

MOUNTING DUAL FUEL CHANGEOVER MODELS

These models have a five foot capillary. This capillary establishes the maximum distance between the case and the outdoor mounting.

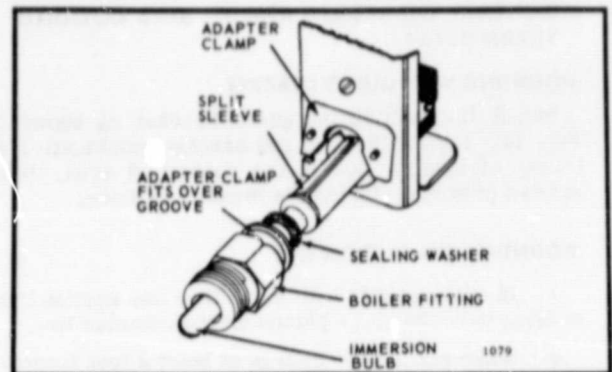


FIG. 12—DIRECT IMMERSION MODEL WITH BULB COMPRESSION FITTING PARTIALLY REMOVED.

The bulb should be installed on the outside of the building in the shield provided (see Fig. 13) where it will be exposed to representative air temperature, but not to direct sunlight. It should be mounted high enough so that accumulated snow, leaves, or other debris cannot obstruct circulation of air around it, and where children cannot reach it. Avoid vents from the building.

Install the case at the indoor location selected, fastening with screws through holes in back of the case. Bring the bulb and tubing out through a 3/4 inch hole in the outside wall. In uncoiling the tubing, carefully avoid sharp bends or kinks. Excess tubing should be left coiled near the case. Do not make sharp bends near the case or bulb.

Slip the bulb through the supports in the shield. Pinch the split supporting clip until it holds the bulb firmly in position. If the seal-off tube protrudes from under the shield, it may be bent under as shown in Fig. 13.

Hold the shield over the mounting position and form a small-radius bend in the tubing. Place the split plug around the tubing and move the shield into mounting location as a unit. Push the split plug into the hole until it is wedged securely in place. Fasten the shield in place on the wall with the screws provided.

NOTE: If the tubing is properly shaped and the split plug installed as directed, the shield will cover the split plug, and the hole in the wall will be hidden from sight.

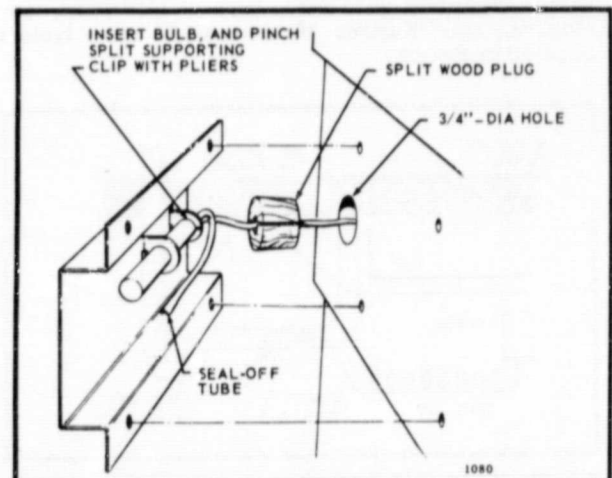


FIG. 13—MOUNTING BULB IN SHIELD OUTSIDE BUILDING.

MOUNTING THE L6008A REMOTE BULB COOLING THERMOSTAT

MOUNTING WITH GUARD BRACKET

Mount the bulb in the guard bracket as shown in Fig. 14. Locate the bulb and bracket combination in freely circulating air in the controlled area. With screws provided, fasten the bracket in place.

MOUNTING ON SUCTION LINE

1. In cooling units with more than one suction line, sensing bulb should be placed on the common line.

2. Make certain the bulb is at least 2 feet from the point at which the suction line leaves the cooler. This will prevent the outside temperature from being transmitted to the remote bulb through the copper tubing of the suction line.

3. Place the remote sensing bulb on the side of the horizontal suction line between the coil and trap (not on the trap).

4. Attach the sensing bulb to the suction line with clips or straps.

5. Coil the excess length of capillary tubing near the L6008A case.

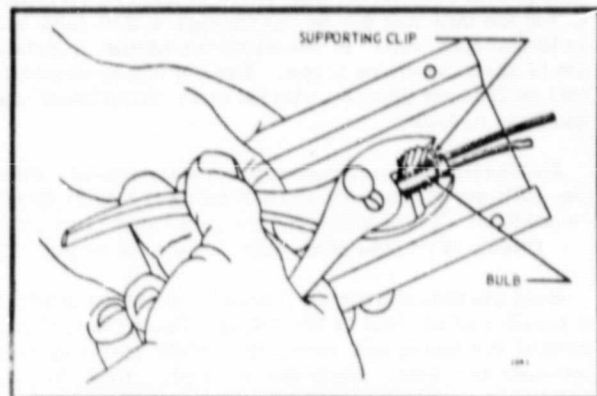


FIG. 14—SECURING REMOTE BULB IN CLIP.

WIRING

All wiring must comply with local codes and ordinances regarding wire size, type of insulation, enclosure, etc. Figures 16 through 23 show typical hook-up diagrams.

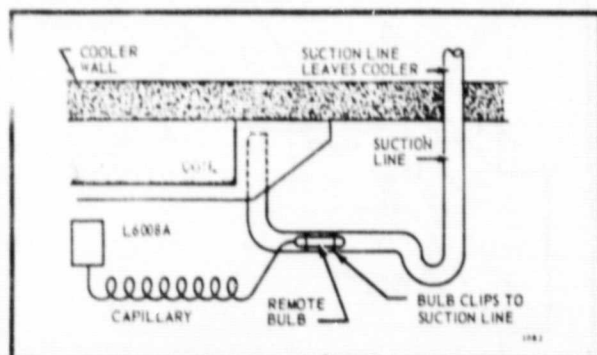


FIG. 15—ATTACHING REMOTE BULB TO HORIZONTAL SUCTION LINE.

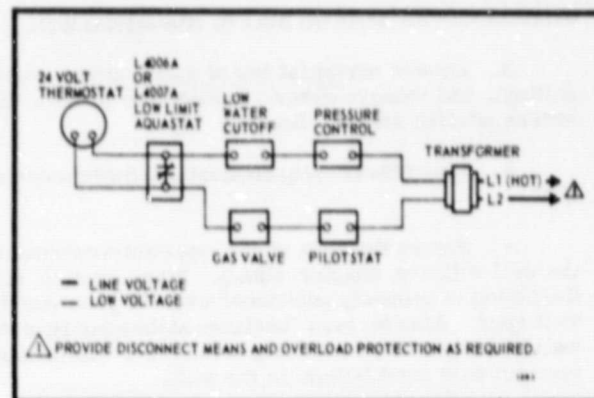


FIG. 16—TYPICAL GAS-FIRED SYSTEM WITH DOMESTIC HOT WATER.

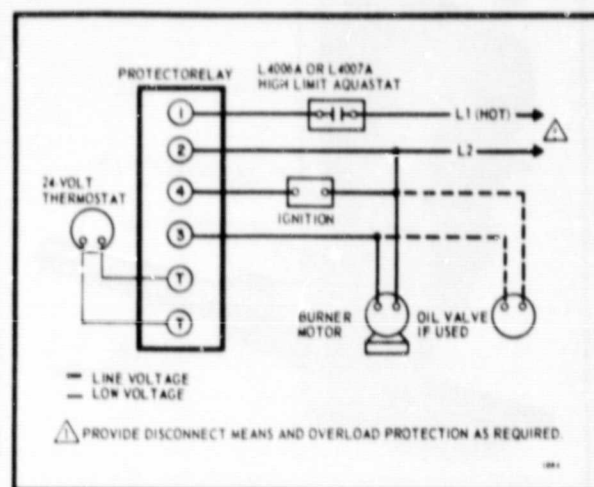


FIG. 17—TYPICAL OIL-FIRED GRAVITY SYSTEM.

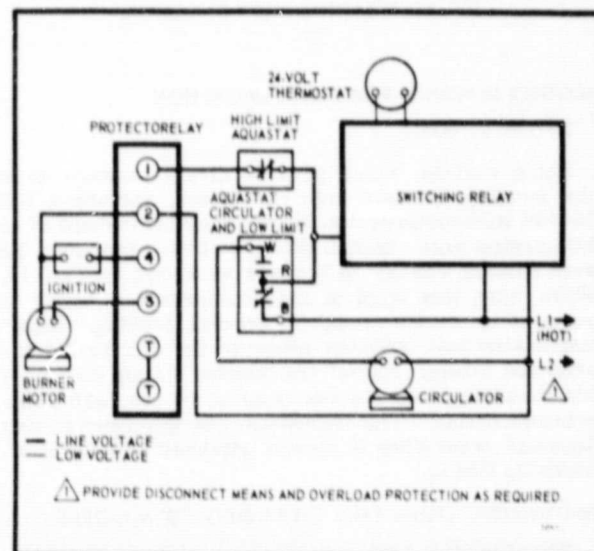


FIG. 18—TYPICAL OIL-FIRED HYDRONIC SYSTEM WITH DOMESTIC HOT WATER.

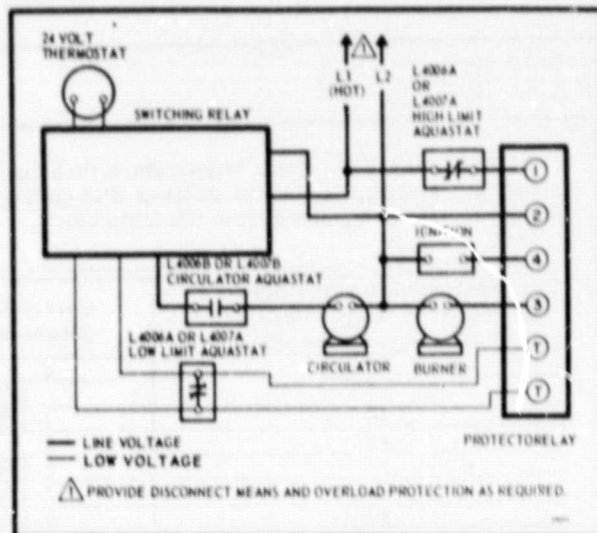


FIG. 19—OIL-FIRED SUMMER-WINTER HYDRONIC SYSTEM WITH DOMESTIC HOT WATER.

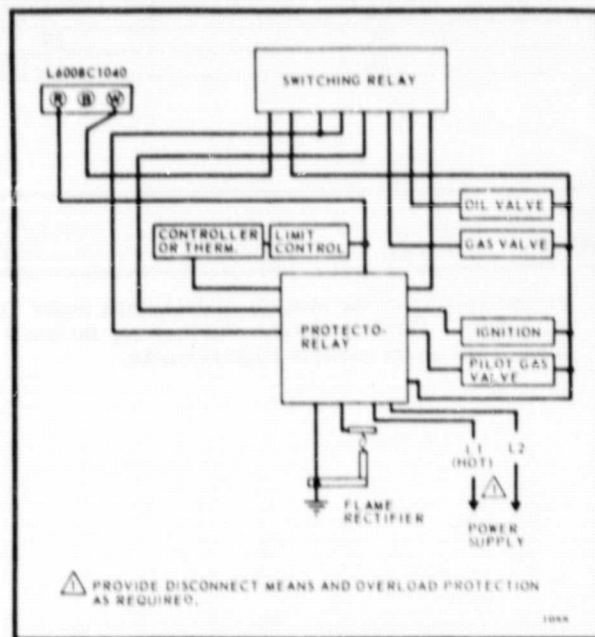


FIG. 20—TYPICAL WIRING DIAGRAM FOR L6008C1040 USED TO SWITCH FROM GAS TO OIL ON TEMPERATURE DROP.

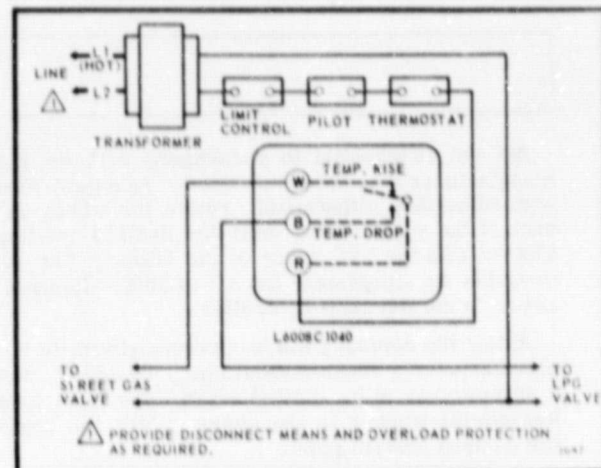


FIG. 21—TYPICAL WIRING DIAGRAM FOR L6008C1040 USED TO SWITCH STREET GAS TO LPG ON TEMPERATURE DROP.

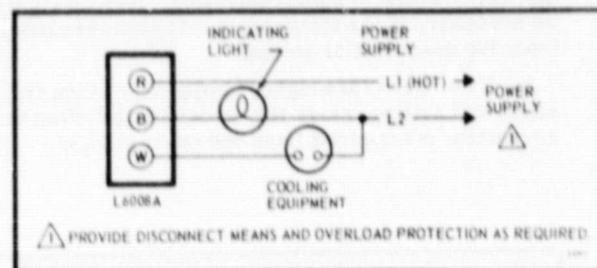


FIG. 22—L6008A USED TO CONTROL COOLING EQUIPMENT AND INDICATING LIGHT.

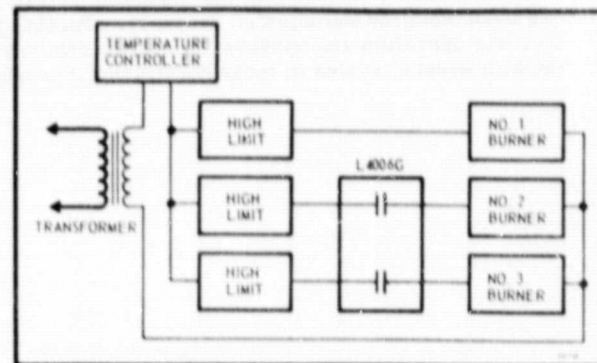


FIG. 23—TYPICAL HOOKUP FOR L4006G BOILER SEQUENCING AQUASTAT.

OPERATION

For proper selection of settings, follow the boiler manufacturer's recommendations.

HIGH LIMIT CONTROLLER

Shuts off burner if water temperature exceeds high limit setting. Burner restarts when temperature drops to high limit setting, less differential.

NOTE: On manual reset models, the reset button on the front of the case must be pushed in to allow the burner to operate after a high limit shutdown.

LOW LIMIT CONTROLLER

Maintains minimum boiler temperature for domestic hot water. Turns on boiler at temperature setting, minus differential.

CIRCULATOR CONTROLLER

Prevents circulation of water that is below the desired heating temperature. Breaks circulator circuit on temperature drop below setting minus differential, remakes on rise to setting.

ADJUSTING

Set the differential to correspond with the boiler manufacturer's recommendations. To adjust models with adjustable differential, rotate the wheel on the back of the snap switch until the desired reading is aligned with the "V" notch in the frame. The wheel provides an adjustment from 5 to 30 F. Replace the cover on the Aquastat controller.

Adjust the control point to correspond with the boiler manufacturer's recommendations. To adjust, insert a screwdriver in the slotted screw-type head located beneath the window in the cover. Turn the scale to the desired control point.

L6008A LOCATION DIFFERENTIAL CALIBRATION

The L6008A1093 is calibrated for applications with both the bulb and case located in the room in which the temperature is being controlled. A correction will be necessary if the temperature of the case is different from the desired dial setting.

1. If the case is at a higher temperature than the desired dial setting, raise the desired dial setting by the correction determined from the table at right.

2. If the case is at a lower temperature than the desired dial setting, lower the desired dial setting by the correction determined from the table below.

Temperature difference between desired room temperature and case temperature (F)	Correction (Degrees F)
0	0
5	3/4
10	1-1/2
15	2
20	2-3/4
25	3-1/2
30	4-1/4
35	5
40	5-3/4
45	6-1/2
50	7
55	8
60	8-1/2
70	10
80	11-1/2

CHECKOUT

Check to make certain that the Aquastat controller has been installed and adjusted properly. Put the system into operation and observe the action of the device through several cycles to make certain that it provides

proper control of the system as described under OPERATION. Further adjustments then can be made to meet more exact comfort requirements.



MAINTENANCE AND REPAIR

LP914A & LP915A PNEUMATIC TEMPERATURE SENSOR

INTRODUCTION

These instructions cover general maintenance, repair and parts replacement for the LP914A and LP915A Pneumatic Temperature Sensor. Exploded view drawings and parts lists are included to facilitate repair. The parts are listed by part number and description. Standard tools may be used to maintain this device. For ordering information, see the note following the drawings.

MAINTENANCE

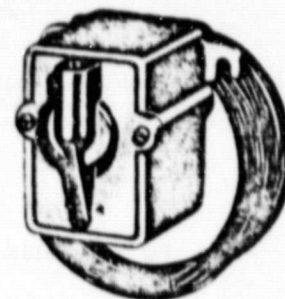
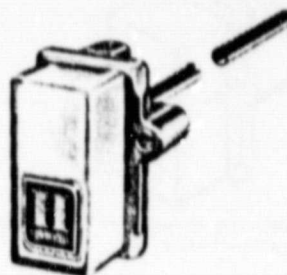
INSPECTION AND CLEANING

Visually inspect the LP914 and LP915 sensor for any physical damage. Remove accumulated dust, dirt or grease with a soft brush using inhibited 1, 1, 1-trichloroethane available locally as Chlorothene or Vythene.

CAUTION: Special care should be exercised in the use of solvents. Avoid prolonged inhalation and/or contact with the skin. Careless handling of solvents can result in permanent damage to the respiratory system and skin tissue.

Change filters and screens if necessary.

Because of the need for highly specialized precision calibration equipment, further periodic maintenance, repair, or adjustment in the field, is not recommended.



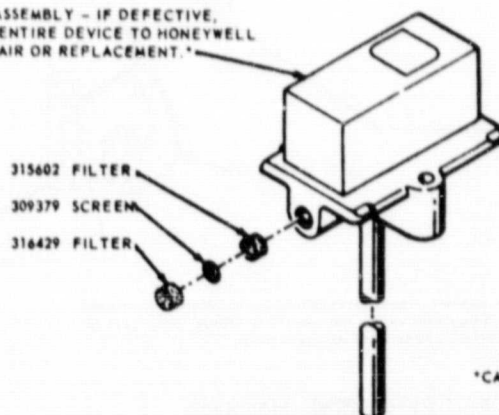
The LP914 and LP915 sensors are sealed after factory calibration. If the sensor should fail to perform as expected, the entire device should be returned to Honeywell for repair or replacement.

OPERATIONAL CHECK

A quick operational check may be performed by raising the temperature at the sensing element. The output pressure should increase. Lower the temperature and the output pressure should decrease.

PARTS LIST

SENSOR ASSEMBLY - IF DEFECTIVE,
RETURN ENTIRE DEVICE TO HONEYWELL
FOR REPAIR OR REPLACEMENT.*

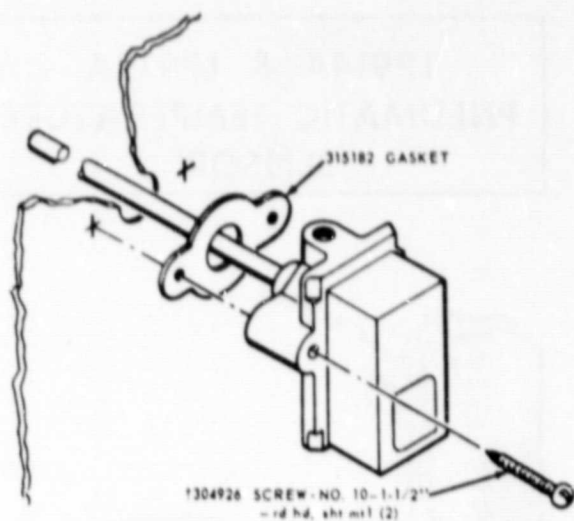


*CAUTION: TO PROTECT CRITICAL ADJUSTMENTS
ON THE LP914, DO NOT REMOVE COVER.

Fig. 1—LP914A Pneumatic Temperature Sensor.

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Form Number **75-5527**
Commercial Div.



*Standard parts (screws, washers, electrical components, etc.) should be obtained locally when possible. Component values are subject to change without notice. Always use exact replacement parts when making repairs.

Fig. 2—LP914A (Duct-mounted).

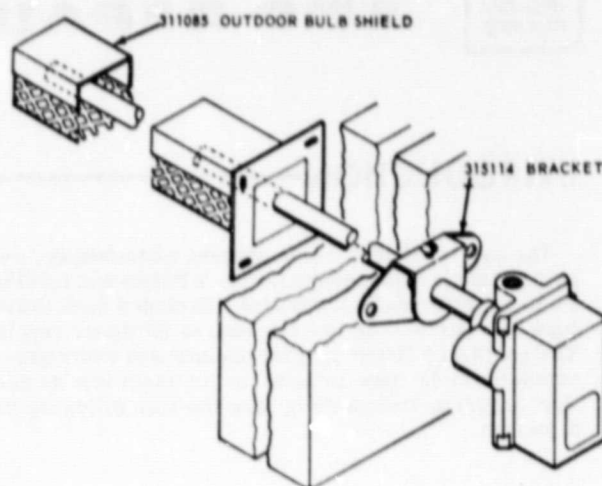
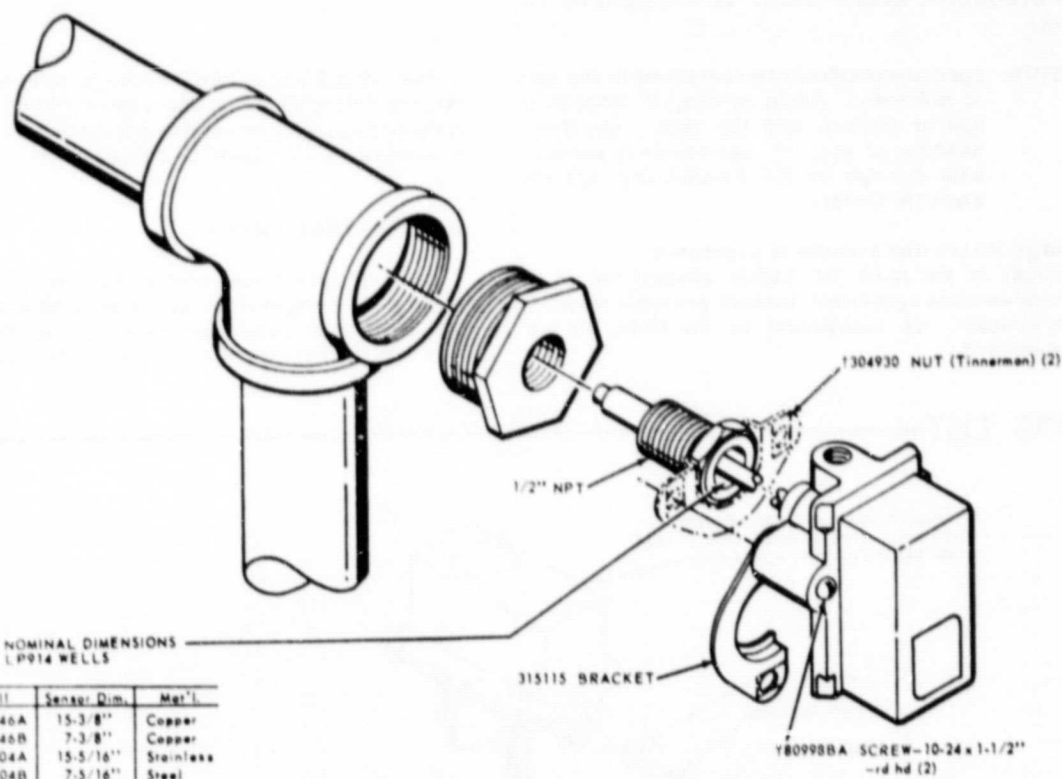


Fig. 4—LP914A (Wall-mounted with inert section).



*Standard parts (screws, washers, electrical components, etc.) should be obtained locally when possible. Component values are subject to change without notice. Always use exact replacement parts when making repairs.

Fig. 3—LP914A (Well-mounted).

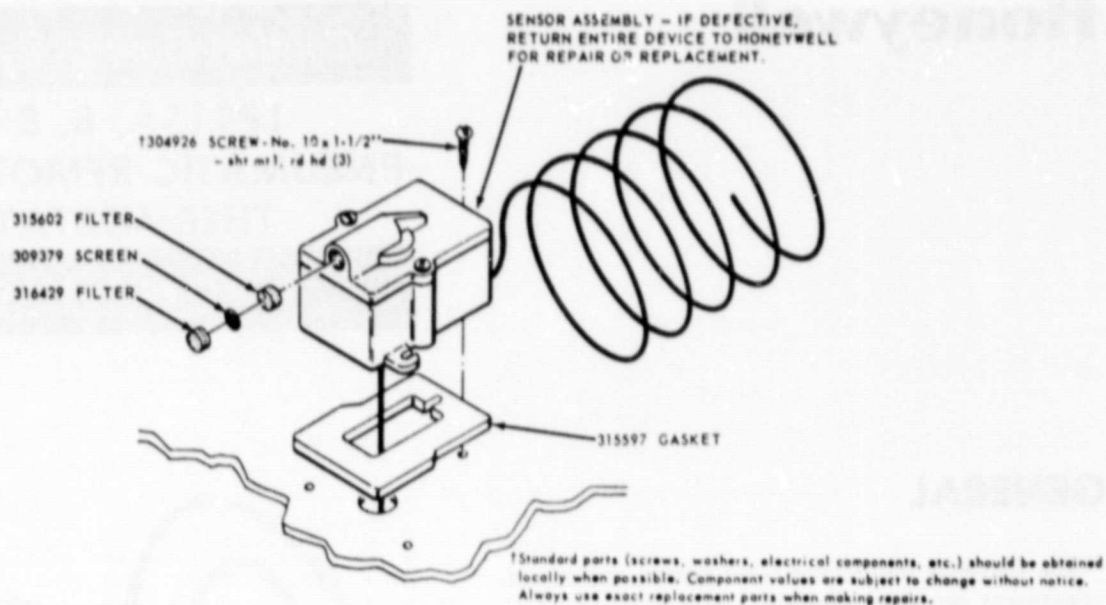


Fig. 5—LP915A (Duct-mounted).

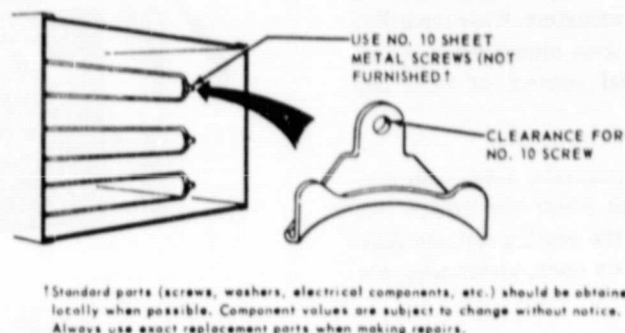


Fig. 6—314439 Capillary Clip (For mounting LP915 tubing in duct).

ORDERING INFORMATION: (In United States.)

—Repair Parts or Assemblies.

Repair parts or assemblies only should be ordered from Honeywell Inc., 1885 Douglas Drive, Minneapolis, Minnesota 55422. Please order by Part No. and Description. Also, give complete Order Specification Number of the sensor. The number is stamped on the sensor body. It may be necessary to return the entire device to our factory for complete repair and reconditioning.

—Return of Complete Device.

When a complete device is returned for repairs, it should be mailed with a repair order to Honeywell Inc., 8330 North Austin Avenue, Morton Grove, Illinois 60053.

—Inquiries on Orders.

Direct all inquiries on orders to Honeywell Inc., 1885 Douglas Drive, Minneapolis, Minnesota 55422.

(In Canada, direct all orders and inquiries to Honeywell Controls Limited, Vanderhoof Avenue, Leaside, Toronto 17, Ontario.)

For prices or further information, contact your nearest Honeywell Branch Office.

Mechanical devices must be serviced periodically if they are expected to give continued satisfactory performance, and controls are not an exception. How accurate and how troublefree your control system will be in the years to come depends largely on the maintenance given it. For best results, all devices in your system should be serviced at one time.

Time and trouble can be saved by arranging with Honeywell for a maintenance agreement which will guarantee expert, economical care, and insure maximum life and efficiency from your system.

LP916A, B, & C PNEUMATIC REMOTE BULB THERMOSTATS

Service Data

GENERAL

The following instructions cover general service and replacement procedures for the LP916 Pneumatic Remote Bulb Thermostats. These unit-mounted pneumatic temperature controllers proportionally control induction units, fan coil units, and unit ventilators. Wide throttling range models are available for duct mounting in HVAC systems, providing proportional control of valve and damper operators.

Direct acting LP916A Thermostats, used with normally open heating valves, will lower the branch line pressure as the temperature at the sensing element falls. This causes the valve to modulate open, maintaining the return air setpoint temperature.

The LP916B Thermostats include an automatic switchover mechanism. A main line pressure of 13 psi (90 kPa) provides a reverse action (cooling) while a main line pressure of 18 psi (124 kPa) provides direct action (heating).

The LP916C Thermostat is factory set and adjusted for reverse action only. When applied with a normally



open valve for cooling control, the branch line pressure drops with a rise in return air temperature. This causes the valve to modulate open, maintaining the return air setpoint temperature.

SPECIFICATIONS

MODELS:

- LP916A - Direct acting, single temperature.
- LP916B - Direct acting at 18 psi, reverse acting at 9 or 13 psi.
- LP916C - Reverse acting, single temperature.

MAXIMUM SAFE AIR PRESSURE: 25 psi (173 kPa).

MAXIMUM SAFE TEMPERATURE:

- Duct mounted models - 190 F (88 C).
- Other models - 135 F (57 C).

AIR CONNECTIONS: Two 1/4-inch (6 mm) OD connections on PCV pigtails (main is red, branch is black).

MAINTENANCE

Remove the cover and clean all surfaces, using a cleaning solvent if necessary. Chloroethene or vythene solvent (containing trichloroethane, inhibited 1,1,1) is recommended. This solvent can be obtained at any office supply store.

CAUTION: Careless handling of solvents can result in permanent damage to the respiratory

system or skin. Avoid prolonged inhalation of vapors or contact with the skin.

Clean the element and capillary tubing also, making certain neither is damaged or kinked. Do not bend the capillary tubing to an extreme angle.

CALIBRATION AND ADJUSTMENTS

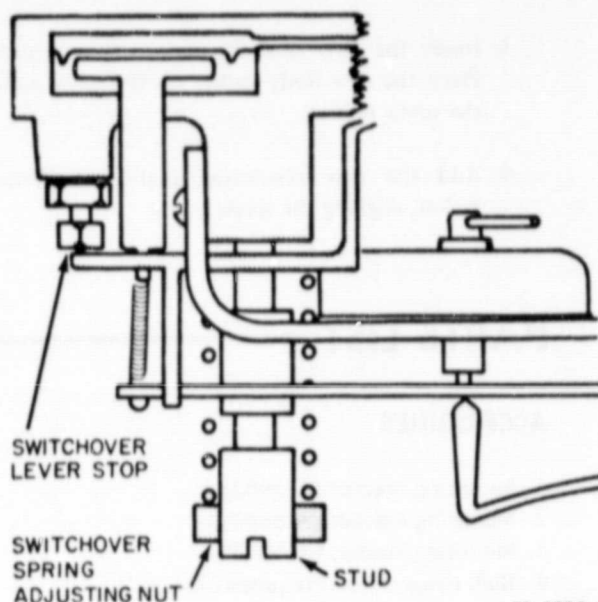
To check operation and calibration, first insert a 0 to 30 psi (0 to 207 kPa) gauge into the gauge plug on the front of the device, using gauge adaptor 315161A. Turn the setpoint knob above and below ambient temperature at the bulb. If the branch line pressure can be varied from 0 psi to full main line pressure within the rated throttling range of the thermostat (either 3.5 or 7 degrees), the thermostat is operating properly. If this operation occurs at ambient bulb temperature, it is calibrated properly. If not, recalibrate according to the following procedure.

LP916A AND LP916C

1. Apply 18 psi (124 kPa) main line pressure.
2. Measure the temperature at the bulb location.
3. Remove the setpoint knob.
4. Rotate the setpoint shaft to achieve 8 psi (55 kPa) branch line pressure. Allow enough time for pressure to build up.
5. Replace the knob and position the pointer at the appropriate division for the temperature sensed by the remote bulb.

LP916B

1. For direct action, follow steps 1 through 5 listed above.
2. For reverse action, apply 13 psi (90 kPa) main line pressure, except when using the LP916B1058. For this model, use 9 psi (62 kPa) main line pressure.
3. Adjust the switchover lever stop (see Fig. 1) to achieve 8 psi branch line pressure. For the B1058 model, branch line pressure should be 6 psi (41 kPa).



75-5559-a

Fig. 1. Automatic Switchover Mechanism of the LP916B.

SWITCHOVER POINT ADJUSTMENT

LP916B switchover point adjustment steps 1 through 3 may be omitted if not required.

1. Back off the switchover spring adjusting nut until it is flush with the stud.
2. Calibrate according to steps 1 through 5 in the Calibration Procedure. Rotating the setpoint shaft clockwise increases branch line pressure.
3. Lower the main line pressure to 16.5 psi (103 kPa). Tighten the switchover spring adjusting nut until the branch line pressure begins to increase.
4. Lower the main line pressure to 13 psi. Adjust the switchover lever stop to 8 psi branch line pressure. Raising the lever stop increases branch line pressure.

REPAIR

If the thermostat operation is sluggish or erratic, replace the filters and the restriction plate according to the steps listed below. A repair kit is available which contains the necessary parts. For part identification, refer to the parts list.

1. Remove the three No. 8-32 x 7/16 pan head screws from the plate and tube assembly.
2. Lift off the plate and tube assembly, restriction gasket, restriction plate, body gasket, and two filters.
3. Insert the two new filters into the air passages. Place the new body gasket on the body and align the screw holes.
4. Add the new restriction plate and restriction gasket, aligning the screw holes.

5. Place the plate and tube assembly in position on the gasket, install the three screws, then tighten.

NOTE: .005 inch restriction plate (14003059-001) has a notched corner. .007 inch restriction plate (314820) does not. These plates are interchangeable, but .007 inch plate is recommended for replacement. Recalibration is required if the restriction plate is replaced.

If air pressure will not decrease in reverse acting models, replacing the thermostat is recommended. If air pressure will not build up in the branch line of direct acting models, disconnect the branch line at the nearest connection to the thermostat. Plug the line to isolate possible leaks to the valve or damper operator and try again. If the pressure still will not build up, replace the thermostat.

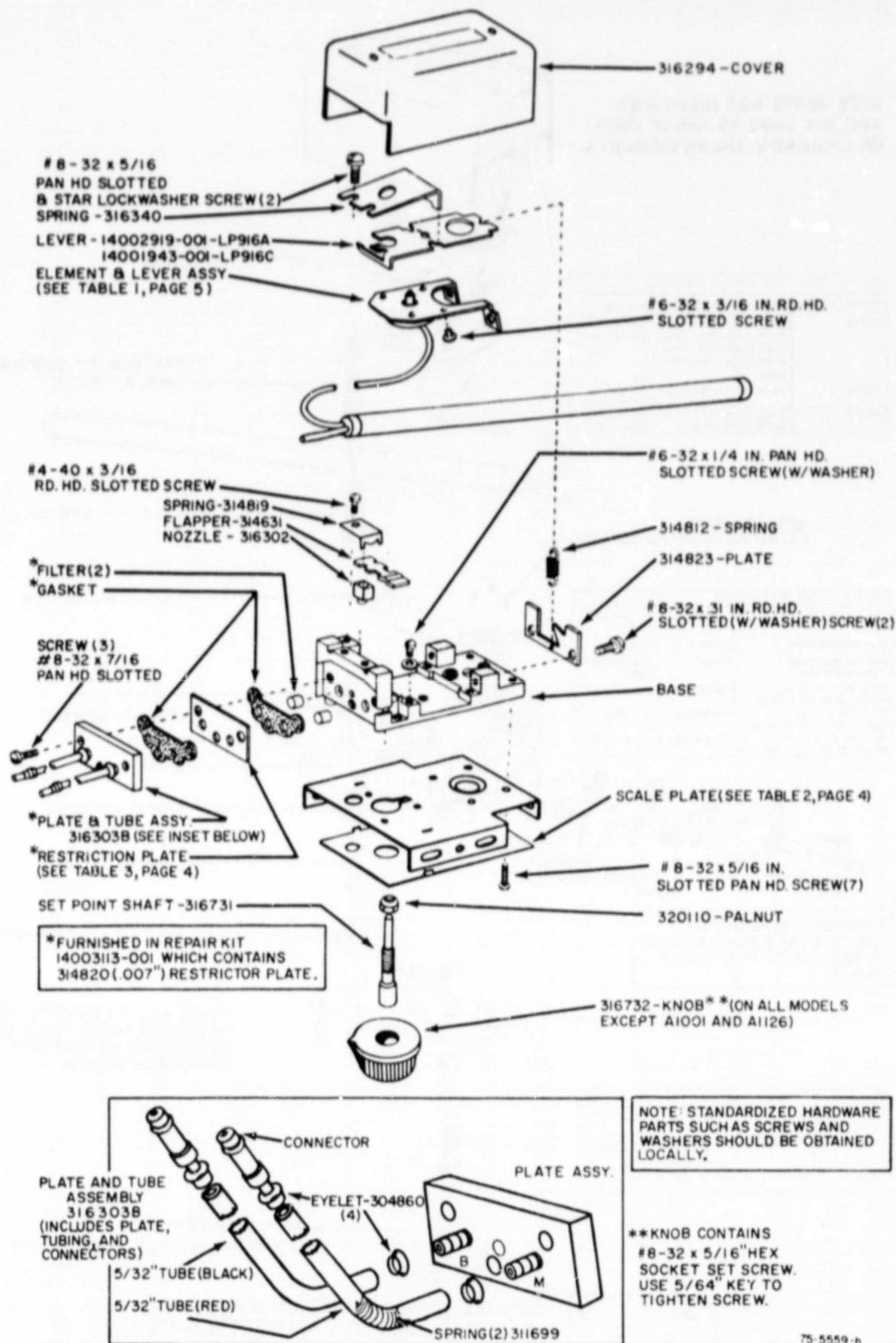
PARTS LIST

ACCESSORIES

1. Mounting bracket (313982)
2. Mounting bracket (315889)
3. Mounting bracket (316073)
4. Bulb hangers - two required (316297)

5. Gulmite head screw wrench (316744)
6. Gauge adaptor (315161A)

For part identification, refer to Figures 2 and 3.



75-5559-b

Fig. 2. Exploded View of the LP916A and LP916C.

NOTE: PARTS NOT IDENTIFIED
ARE THE SAME AS THOSE USED
ON LP916A&B, SHOWN ON PAGE 4

TABLE 1 - LEVER AND ELEMENT ASSEMBLES		
Assembly Part No.	Used On these LP916's	Stud Size
316372A	A1001, A1027, A1066, A1126, A1134, A1159, B1009, B1025, B1011, B1066, B1074, B1062, B1090, B1106, C1007, C1023, C1096	2-8 x 9 1/2 inch (9.5 x 241 mm)
316372B	A1019, B1017, A1066, C1049	1/4 x 5-3/4 in. (12.7 x 146 mm)
316372C	A1035, A1076, A1118, A1142, A1175, C1096, C1114	3/8 x 6-3/4 in. (9.5 x 171.5 mm)

TABLE 2 - SCALE PLATE RANGES		
Scale Range	Scale Part No.	Available on Model No.
Warmer Neutral Cooler	316708	All LP916's
Red and Blue Bands (International Use)	317043	A1066, A1076, B1041
56 to 95 F (13.35 C)	14003040-001	A1118, A1142
Marked 50 to 110 F (10.44 C)		
35 to 115 F (12.46 C)	14003040-002	All LP916's
Marked 50 to 110 F (10.44 C)		
40 to 80 F (4.27 C)	14003040-003	A1118, C1096
Marked 50 to 110 F (10.44 C)		

*FURNISHED IN REPAIR KIT
14003113-001 WHICH CONTAINS
314820 (.007") RESTRICTION
PLATE.

TABLE 3 - RESTRICTION PLATE		
Restriction Plate Part No.	Size Restriction	Available on Model No.
14003059-001	.005 in. (0.127 mm)	A1126, A1134, A1142, A1159, A1175, B1074, B1062, B1090, B1106, C1096, C1106
314820	.007 in. (0.178 mm)	All other LP916's

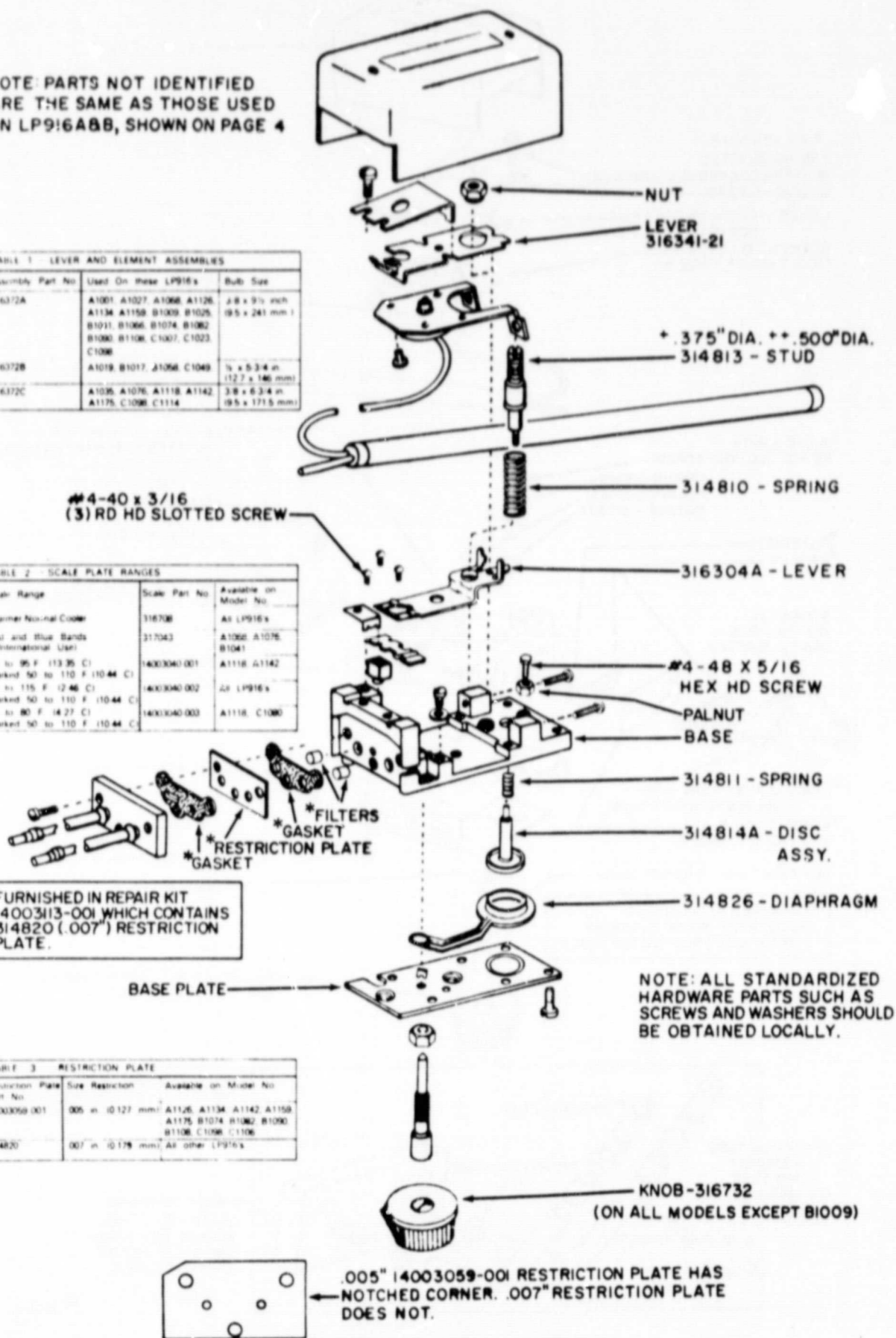


Fig. 3. Exploded View of the LP916B.

75-5559-c

75-5559

MP909A-C PNEUMATIC PISTON OPERATORS

Service Data

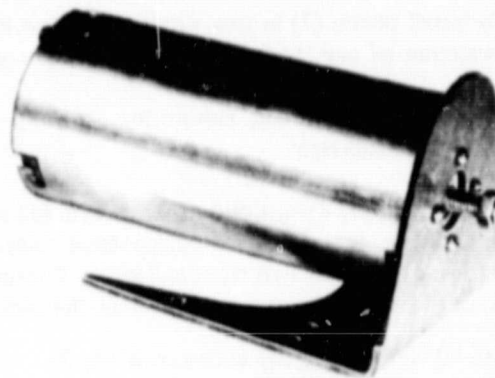
GENERAL

The following information covers service and repair of the MP909A-C Pneumatic Piston Operators.

Suggested repair parts are shown by Honeywell Part Number in the Repair Parts List section. Standard hardware items such as screws, washers, etc. should be obtained locally. Should other parts be damaged or worn-out, the entire motor should be replaced.

Internal damper motor mounting Kit No. 14000716-001 and reversing damper motor linkage Kit No. 14000693-003 are shown in detail in form 95-5553.

Figures 5 and 6 show standard shaft end assemblies. Figure 7 shows standard damper linkage accessories.



APPLICATION

TYPICAL APPLICATION

These motors provide proportional control of standard dampers, air valves and shutters in high velocity mixing boxes.

OPERATION

For standard damper application, the MP909 is controlled directly from branch line pressure from the room thermostat, producing proportional control of the damper.

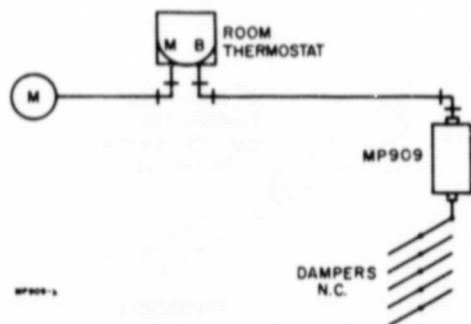


Fig. 1—MP909A Typical Operation.

TROUBLE SHOOTING

1. Check the physical condition of air lines, motor linkages, and performance of operator.

CAUTION: If the motor is manually operated, or if the shaft is rotated, the diaphragm may collapse or wrinkle, resulting in erratic operation.

2. Vary the branch line pressure to the operator and observe its action. As the branch line pressure is increased, the operator should stroke. Operation should be smooth and even.
3. If the motor fails to stroke or operates erratically, disassemble the motor and check the diaphragm and base assembly for damage or wear. Follow the following procedure:

DIAPHRAGM ASSEMBLY REPLACEMENT

Refer to Figures 2 and 3.

The diaphragm may be replaced without removing the fittings or the operator from the mounting bracket.

NOTE: If operator is removed from bracket to replace diaphragm, LEAVE NUT (12) ON SHAFT.

1. To remove end cap assembly, press in on cap (4) to free lugs from lock slot and rotate counterclockwise.

2. When replacing the diaphragm (6) on cup (5), bead on inside of diaphragm **MUST** fit over lip on cup (5).

3. To install piston (7) in new diaphragm, blow into end connection of cup, to fully extend the diaphragm.

4. Place thumb over end connection, to trap air inside extended diaphragm.

5. Place piston (7) against end of diaphragm (6) and push. Allow just enough air to escape from beneath thumb, to prevent diaphragm from collapsing. Continue to push, until diaphragm smoothly envelops the piston.

6. Assemble the spring clip as shown in Fig. 3.

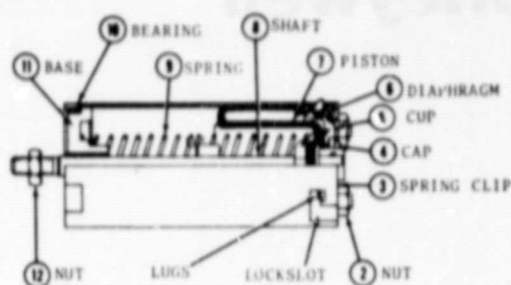


Fig. 2—MP909 Cross-Section Detail.

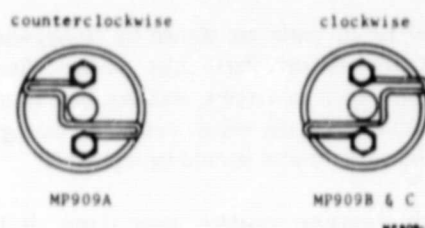


Fig. 3—Spring Clip Installation.

NOTE: Refer to Repair Parts List for part numbers of replacement parts.

DAMPER LINKAGE ACCESSORIES

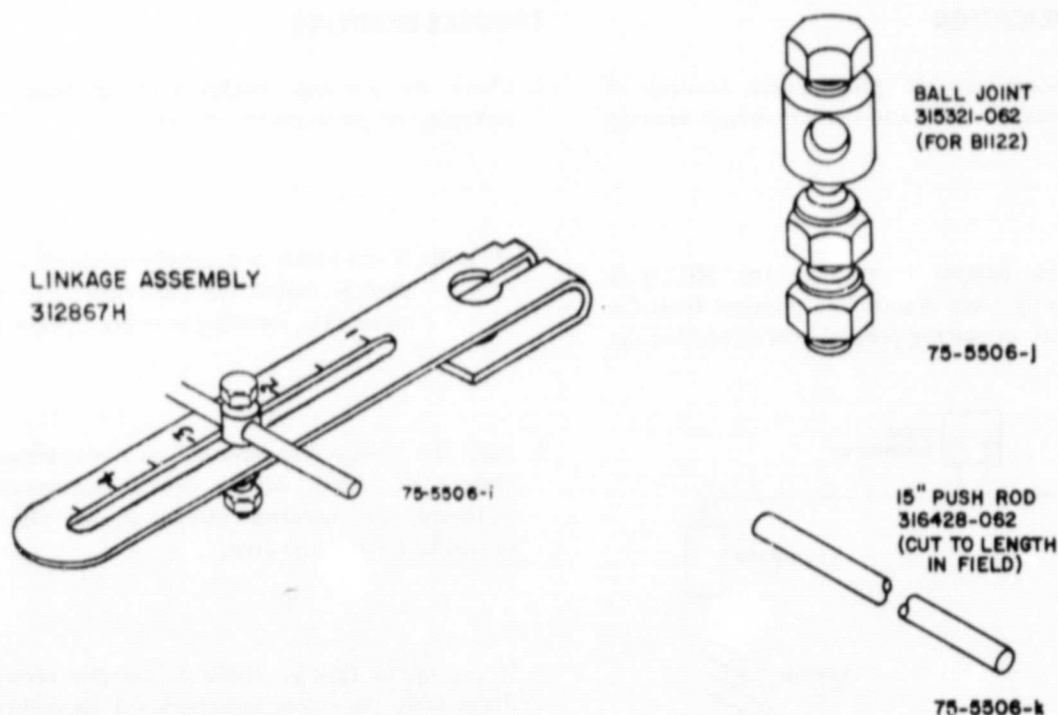
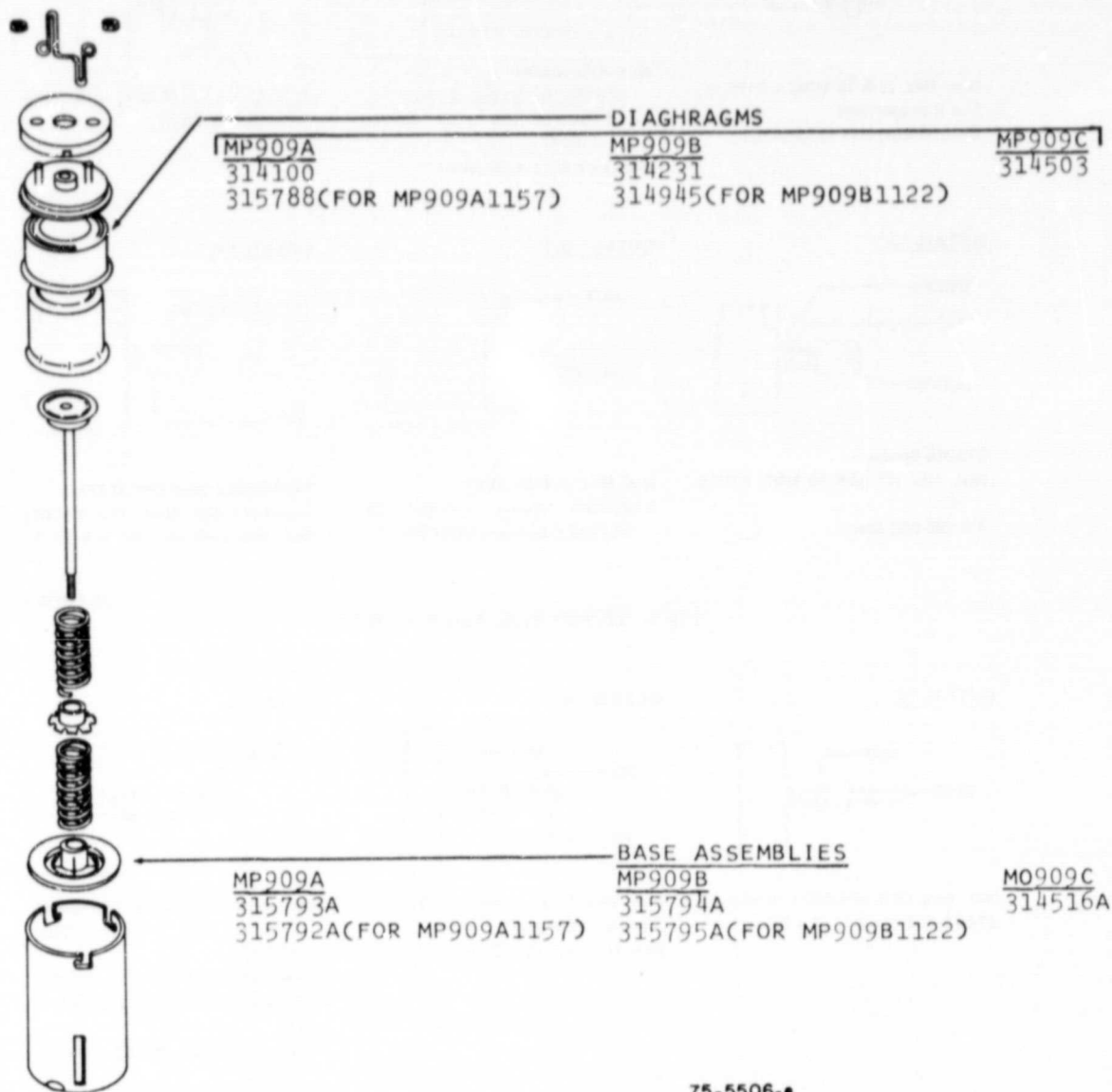


Fig. 4—Standard Damper Linkage Accessories.

MP909 PARTS LIST

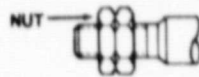


75-5506-6

Fig. 5 -MP909A, B, C Housing Assy.

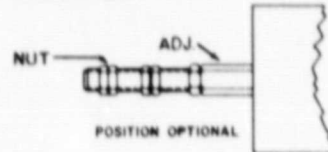
SHAFT END ASSEMBLIES

DETAIL "A"



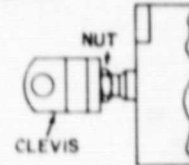
Nut, Hex (3/8-16 UNC x 9/16 in.)
1 or 2 as specified
304219 Nut, Hex (2 for A1512)

DETAIL "B"



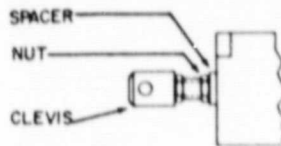
Nut, Adjustment
316149 (for B1355, B1363)
14000973-001 (for B1496,
B1504)
Nut, Hex (5) 1/4-28 JAM

DETAIL "C"



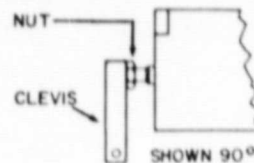
Nut, Hex (3/8-16 UNC x 9/16 in.)
315439-062 Clevis

DETAIL "D"



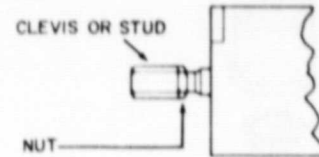
315398 Spacer
Nut, Hex (2) (3/8-16 UNC x 9/16 in.)
315439-062 Clevis

DETAIL "E"



Nut, Hex (1/4-28 JAM)
314709A Clevis (consists of
314709 Clevis & 304851 Pin)

DETAIL "F"

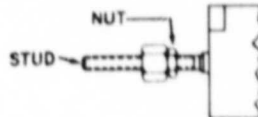


314442-062 Stud (for B1122)
14001013-002 Clevis (for B1569)
Nut, Hex (3/8-16 UNC x 9/16 in.)

75-5506-f

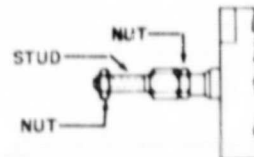
Fig. 6—MP909 Shaft End Assemblies.

DETAIL "G"



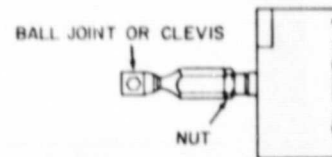
Nut, Hex (3/8-16 UNC x 9/16 in.)
31441-767 Stud (1/4 x 20 in.)

DETAIL "H"



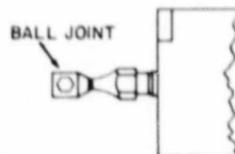
Nut, Hex (3/8-16 UNC x 9/16 in.)
314441-767 Stud
Nut, Hex (1/4-20 x 3/16 in.)

DETAIL "J"



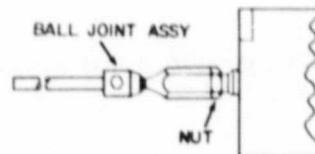
Ball Joint (315781-605 - Standard)
(315887-605 - for A1306,
A1314)
Clevis 14001013-002 (for A1520)
Nut, Hex (3/8-16 UNC x 9/16 in.)
(1).
(2) for B1650, B1668, C1294,
C1302.
Nut, Hex (1/4-28 JAM) (1) for
A1306, A1314.

DETAIL "K"



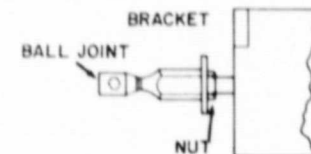
314990-605 Ball Joint

DETAIL "L"



Ball Joint Assy
315546A (for B1114 - 6.4 in.
rod)
315546C (for B1106 - 2x28 in.
rod)
Nut, Hex (3/8-16 UNC x 9/16 in.)

DETAIL "M"



315781-605 Ball Joint
14000923-001 Bracket
Nut, Hex (3/8-16 UNC x 9/16 in.)

75-5506-g

Fig. 7—MP909 Shaft End Assemblies.

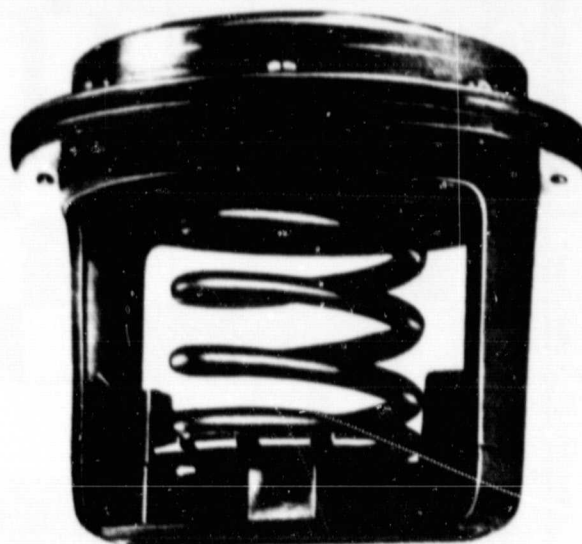
Honeywell

Comfort Control Systems

MP 953A-D PNEUMATIC VALVE ACTUATOR

Service Data

ORIGINAL PAGE IS
OF POOR QUALITY



GENERAL

The MP/MO953 pneumatic valve actuators operate the V5011 and V5013 valve assemblies and with adapters, control older steam and water valves.

The MP953A, available in three sizes and three stem travel lengths, has a positive positioning relay with an adjustable spring range start point of 3 to 10 psi (21 to 69 kPa).

The MP953B, also with a positive positioning relay and adjustable spring range start point, is 7-1/8 in. (181 mm) in diameter and has stem travel lengths of 1/2 in. (13 mm) and 3/4 in. (19 mm).

The MP953C with no positioning relay is available in three nonadjustable spring ranges, three sizes and three stem travel lengths.

The D model with no positioner is available with two nonadjustable spring ranges, is 7-1/3 in. (181 mm) in diameter, and has 1/2 in. (13 mm) and 3/4 in. (19 mm) stem travel lengths.

For further identification, refer to Table 1.

SPECIFICATIONS

MODELS:

MP953A - Direct-Acting, with Positioner
MP953B - Reverse-Acting, with Positioner

MP953C - Direct-Acting, without Positioner
MP953D - Reverse-Acting, without Positioner

Table 1. MO953 and MP953 Model Identification.

Device	Active	Inactive (1978)		Size - Inches (mm)				Travel - Inches (mm)			Max. Temp.*		Spring Range - psi (kPa)				Corrosion Resistant
		MP953	MO953	5 (127)	7-1/8 (181)	8 (203)	13 (330)	1/2 (13)	3/4 (19)	1-1/2 (38)	160 F (71 C)	250 F (121 C)	2 to 7 (14 to 48)	4 to 11 (28 to 76)	8 to 12 (55 to 83)	8 to 13 (55 to 90)	
MP/MO 953A	1210	1087	1004														No
	1228	1095	1012														No
	1111	1103	1046														No
		1079															No
		1145	1020														No
	1244	1038															No
	1152	1178	1053														No
	1269	1202	1186	1061													No
	1069	1002	1036														No
	1044	1010	1044														No
MP/MO 953B		1028	1051														No
MP/MO 953C	1060																No
	1018																No
	1026																No
	1067	1034															No
		1042															No
		1059															No
	1075																No
	1083																No
	1091																No
	1109																No
	1117																No
	1471	1141															No
		1158															No
		1166															No
		1174															No
		1182															No
		1190															No
		1208															No
		1216															No
		1224															No
		1232															No
MP/MO 953D	1489	1414															No
	1107	1008															No
	1131	1115	1016														No
		1123	1024														No
		1073															No
	1172	1081	1149														No
		1099	1156														No
		Sales Special															No
	1214																No
	1222																No

*F---hram color varies with maximum temperature; Black (Neoprene) = 160 F, White (Silicone) = 250 F, Black with White Dot (Ethylene Propylene) = 250 F.
Maximum Safe Air Pressure (all models): 25 psi (172 kPa).

Honeywell

SUBJECT TITLE

MP953A-D PNEUMATIC VALVE
ACTUATOR

Correction ☒

Addition ☐

Errata No. ☐

ERRATA DATA

Literature Type Service Data

For more information contact:

Bill Hoipkemier

Phone HVN 661-5634

Location Arlington Heights

Page 1, "General" section, fifth paragraph:

The MP953D device diameter is 7-1/8"; not 7-1/3".

Page 10, Figure 8:

The part numbers for the high temperature diaphragm and sleeve are reversed. The correct part numbers are:

Diaphragm, 250°F _____ 14002040-001

Sleeve, 250°F _____ 14002039-001

Page 13, Figure 10:

The part numbers for the high temperature diaphragm and sleeve are reversed. The correct part numbers are:

Diaphragm, 250°F _____ 14002040-001

Sleeve, 250°F _____ 14002039-001

ERRATA DATA

Page 1 of 1

M.L.F. Index Code II.C.7

Date 2/15/80

File with Form Number 75-5500 dtd. 8/78

Commercial Div.

APPLICATION

These pneumatically powered actuators operate V5011, V5013, or certain older coil or line valve assemblies which proportionally control steam or hot or cold liquids in HVAC systems.

OPERATION

MP953A & B (With Grad-U-Trol*)

The force balance of the valve unit lever pivot and ball check arrangements establishes a true proportional relationship between the diaphragm cup position and the pilot air pressure which is independent of the shaft load. The operating (control air) pressure range is directly pro-

portional to the feedback spring rate and the cup travel. (Decreasing pilot diaphragm area increases the operating range.) The clinching forces are available at all positions of the diaphragm cup, equal to the main supply air pressure force acting on the operator diaphragm cup less the operating spring load at the corresponding cup position.

MP953C & D (Without Grad-U-Trol)

The actuator has a rolling diaphragm operated piston-like cup to build thrust as the actuator inlet pressure increases. The spring loaded cup returns as the actuator inlet pressure decreases.

MAINTENANCE

Periodically make a visual check for leaks, loose fittings, etc. Clean the actuator with a commercial cleaning solvent or degreaser. Keep solvent away from the diaphragm as it causes deterioration.

CAUTION

Careless handling of solvents can result in permanent damage to the respiratory system or to the skin. Avoid prolonged inhalation or contact with the skin.

OPERATIONAL CHECK

Vary the branch line pressure through the operational range of the actuator in both directions. The valve should open and close smoothly.

ADJUSTMENTS

NOTE: Adjustments are necessary only for the Grad-U-Trol relay used with the MP953A and B actuators (see Fig. 1).

TO SET OPERATING RANGE

Select the proper range and adjust as follows:

1. Using wrench (Part No. 301572A), loosen the cover locking screw.

2. Unscrew the start point adjustment knob and remove cover.

- a. For three psi (21 kPa) range, back all screws off to friction stop.
- b. For five psi (34 kPa) range, back only the black screws to stop and tighten the outer plated screws.
- c. For ten psi (69 kPa) range, tighten all the screws.

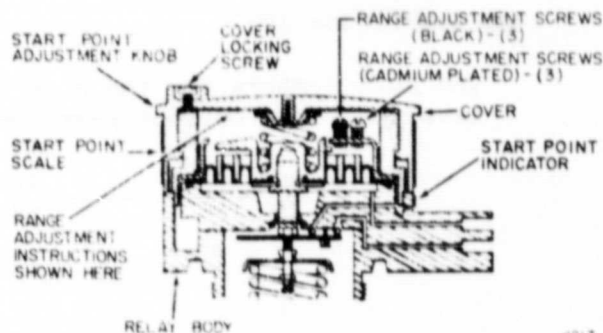


Fig. 1. Adjustment Points of Gradutrol Relay.

TO SET START POINT

1. Tighten the cover by turning it until it bottoms on the relay body.
2. Back off (one turn maximum) until the start point of the correct scale range lines up with the start point indicator near "B" marking.
3. Tighten the cover locking screw until it engages the relay body. Do not overtighten.

ADJUSTMENT CHECK

1. Install gages in the main and pilot air lines.
2. Verify main air pressure. It must be at least 13 psi (90 kPa) if top of sequencing range exceeds 13 psi (90 kPa).
3. Slowly apply pilot pressure and note the pressure at which the valve stem travel starts. This pressure should be within $\pm 3/4$ psi (5 kPa) of the start point setting.
4. Slowly increase the pilot pressure until the valve stem travel is complete. This pressure should be the start point pressure plus the range setting.
5. If necessary, make fine adjustments with the start point adjustment knob.

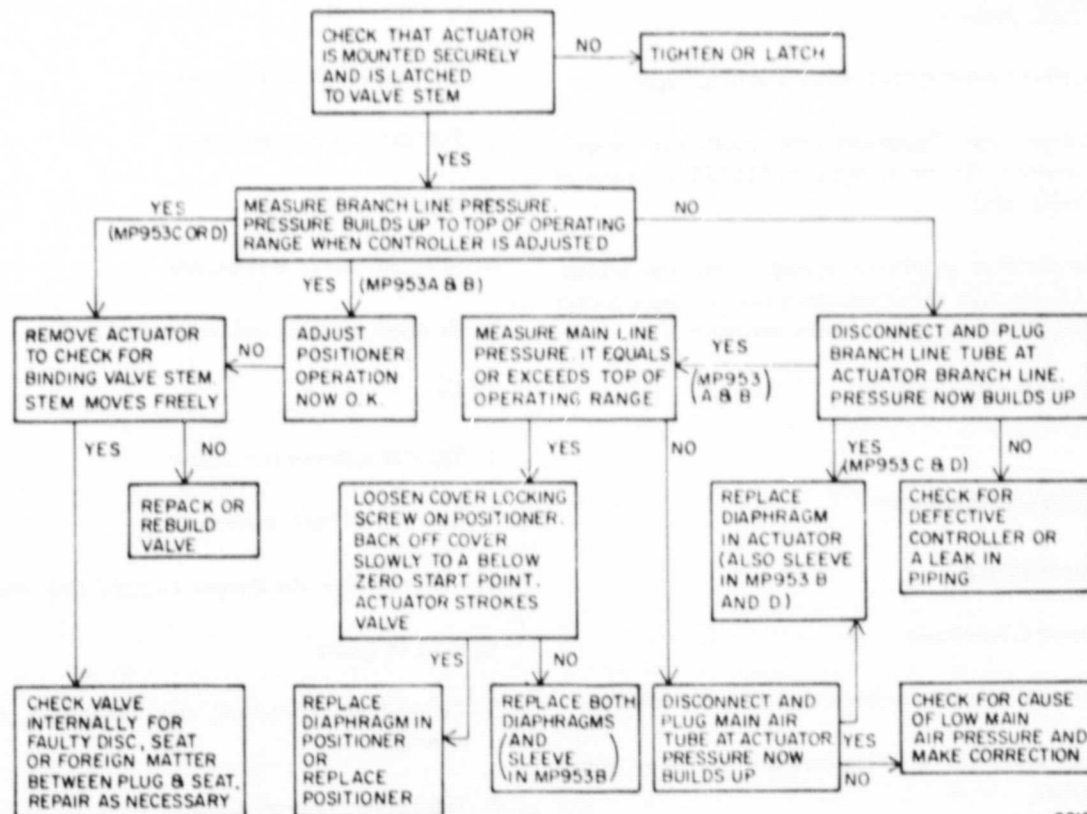
CAUTION

Loosen the cover locking screw *before* turning the start point adjustment knob.

TROUBLESHOOTING

Symptom	Remedy
MP953A closes too slowly or MP955B opens too slowly.	Replace the filters in positioner relay ports. Replace restrictor if one exists. Add booster relay if controller is too low for the application.
MP953A or C Valve won't open or MP953B or D Valve won't close.	Check that actuator is mounted securely and latched to valve stem. Check controller action. Assure proper bleed off occurs. Check for internal valve problems, foreign objects under seat, defective disc or seat, plug unscrewed, etc.

MP953A & C - WON'T CLOSE VALVE
MP953B & D - WON'T OPEN VALVE



8818

Fig. 2. Troubleshooting Flowchart for MP953.

REPAIR

Special tools required:

Pliobond Glue or equivalent to replace MP953A diaphragm

DIRECT ACTING (MP953A & C)

DIAPHRAGM REPLACEMENT

Before attempting replacement, determine type and material of existing diaphragm. Both neoprene and ethylene propylene (EPR) are black but EPR has a white spot. Neoprene and EPR diaphragms are interchangeable but should be applied to suit maximum temperature requirements (EPR used for 250 F [121 C]). Old style flat diaphragms and newer beaded roll types are not interchangeable. Silicone (white) diaphragms are used in 250 F (121 C) applications on MP953A and C models. EPR is used on B and D models only.

1. Disconnect air line(s).
2. Loosen two base setscrews to partially relieve spring preload.
3. Remove cover screws, cover and diaphragm.
4. Install new diaphragm (for positioner models, cement positioner spring cup, 315178, to center of diaphragm).
5. Reassemble positioner spring, cover and screws. (Use cap type allen head setscrews to replace socket head setscrews used on older actuators.)
6. Tighten base setscrews.

FILTER REPLACEMENT

1. Remove tubing.
2. Remove Connectors.
3. Remove filters with pointed tool such as an awl.
4. Install foam filters, taking care not to fold or bunch together.
5. Reinstall Connectors and tubing.

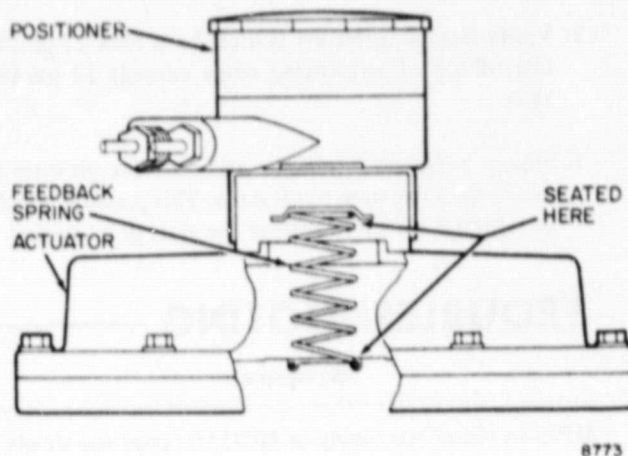


Fig. 3. MP953A & C Positioner Replacement.

MAIN SPRING REPLACEMENT

Springs with different ranges are interchangeable on the same size actuators. Select spring by operating range and stem travel. (See Table 2 for MP953C and parts list for MP953A.)

5 IN. AND 8 IN.

1. Remove actuator from valve.
2. Remove two base setscrews.
3. Replace spring.
4. Reinstall two base setscrews.
5. Reinstall actuator and latch of valve stem.

13 IN.

1. Remove actuator from valve.
2. Loosen two base setscrews.
3. Remove cover, diaphragm, cup and stem retainer.
4. Replace spring.
5. Reinstall stem retainer, cup, diaphragm, cover and screws.
6. Tighten two base setscrews.
7. Reinstall actuator and latch to valve stem.

POSITIONER REPLACEMENT (See Fig. 3)

1. Disconnect air lines.
2. Unscrew positioner from actuator cover, taking care not to lose feedback spring.
3. Screw new positioner in place, being sure new "O" ring is properly seated in positioner groove. (Reuse old feedback spring as this is not included in 313695J assembly.)
4. Tighten only enough to seat "O" ring.
5. Adjust positioner for range and start point.

REVERSE ACTING (MP953C & D)

DIAPHRAGM REPLACEMENT

NOTE: Replace both diaphragm and sleeve (inner seal) when replacement of either is indicated. Use **SERVICELINE** Kit 14003124-001 for 160 F (71 C) device. Select replacement diaphragms by maximum temperature requirements (160 F [71 C]) Standard Applications—neoprene; 250 F [121 C] high temperature applications—EPR).

MP953B

1. Disconnect air lines.
2. Remove cover screws, cover, feedback spring, nut 312205, lockwasher 304733, cup and diaphragm.
3. Replace diaphragm.
4. Reinstall cup, lockwasher and nut.
5. Tighten nut only enough to seal diaphragm.
6. Reinstall feedback spring, cover and screws.

MP953D

1. Disconnect air lines.
2. Remove cover screws, cover and diaphragm.
3. Replace diaphragm.
4. Replace cover and screws.
5. Reconnect air lines.

SLEEVE (Inner Seal) REPLACEMENT

1. Remove diaphragm (follow steps 1 and 2 above).
2. Remove cup 302201, three screws, ring 312180 and sleeve (inner seal).

3. Replace sleeve (inner seal).
4. Reinstall ring, screws, cup and diaphragm.
5. Follow steps 4 and 5 for D model (4 through 7 for B models) above to complete repair.

MAIN SPRING REPLACEMENT

Select spring by operating range and valve stem travel. Springs are interchangeable if operating range and valve stem travel are the same. For MP953D, see Table 3 and for MP953B, see parts list.

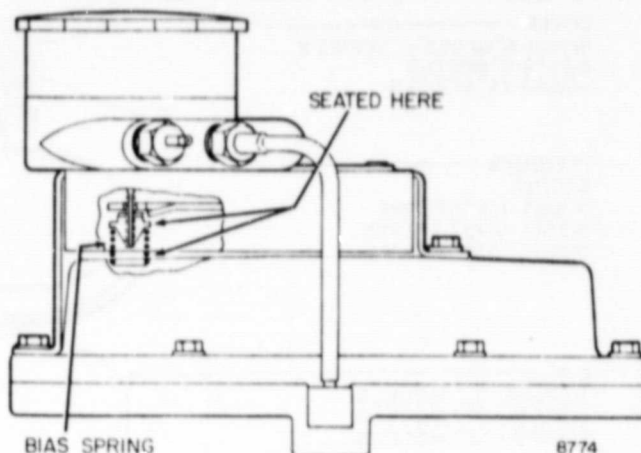


Fig. 4. MP953B Bias Spring Position.

1. Remove diaphragm and sleeve (inner seal) (see above).
2. Remove two base screws and base.
3. Replace main spring.
4. Reinstall base, two screws, sleeve and diaphragm.
5. Follow steps 4 through 7 for B models and 4 and 5 for D models in DIAPHRAGM REPLACEMENT.

POSITIONER REPLACEMENT (See Fig. 3 and 4)

1. Remove air lines and two screws from positioner assembly.
2. Replace positioner assembly being sure bias and feedback springs are properly seated.
3. Adjust positioner for proper range and start point.

Figure 7 illustrates parts used in the old MO953 A4 and A8 Series 3 through 7. These parts are not available. If repair is necessary, convert the actuator to a new style device by installing the new parts listed in Figure 7.

PARTS

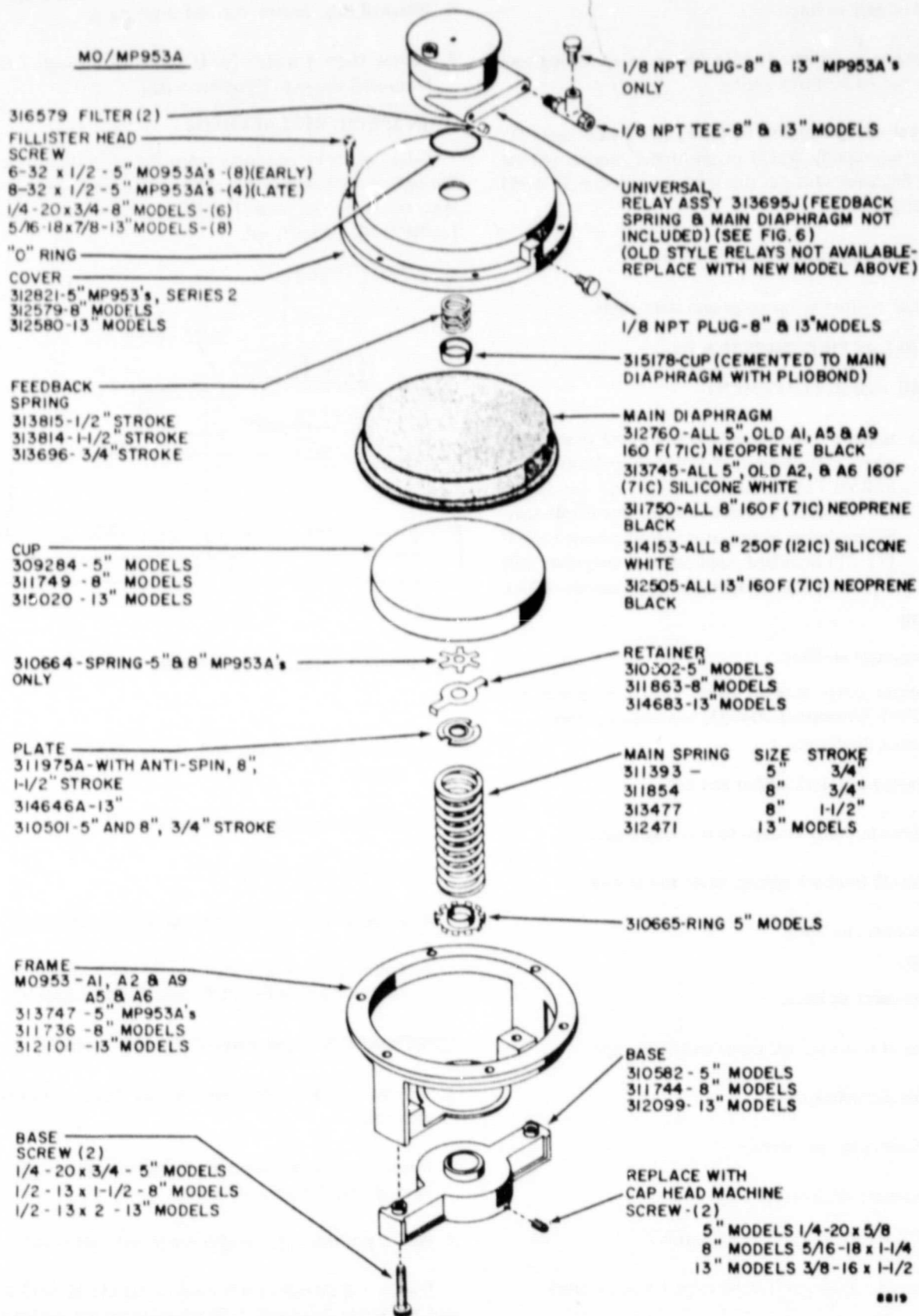


Fig. 5. Exploded View.

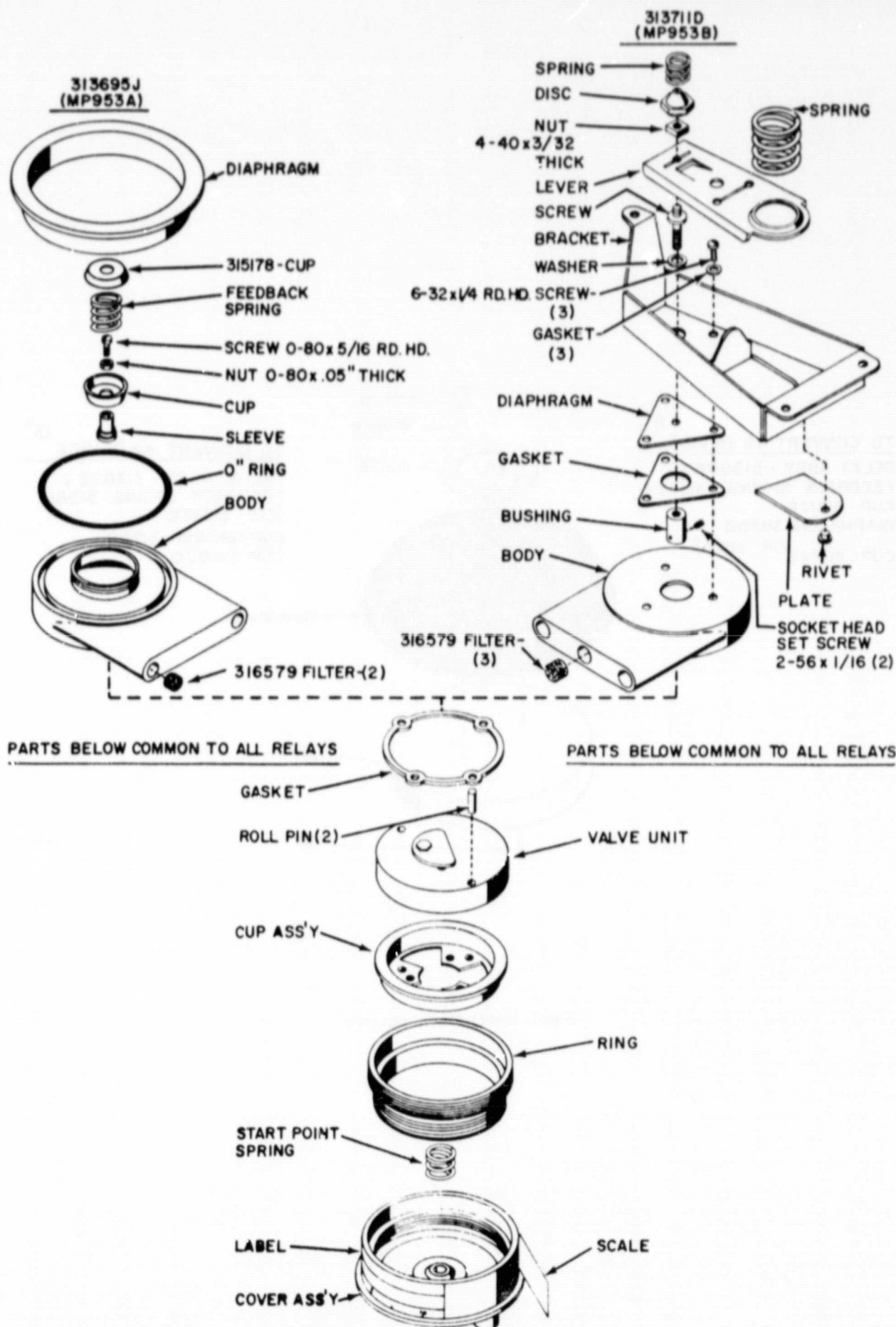
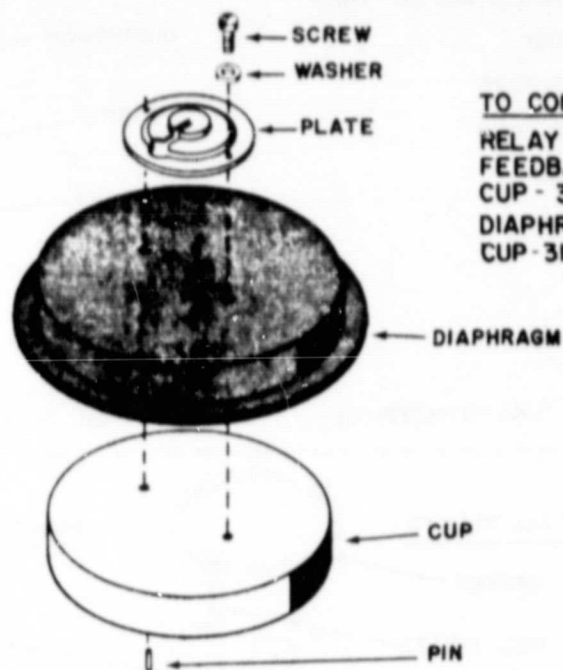


Fig. 6. Relay Assemblies—Exploded View.

6620

8"
TO CONVERT A4 DEVICE
 RELAY ASSY. - 313695 J
 FEEDBACK SPRING - 313696
 CUP - 315178
 DIAPHRAGM - 311750
 CUP - 311749 OR 314153



13"
TO CONVERT A8 DEVICE
 RELAY ASSY. - 313695 J
 FEEDBACK SPRING - 313814
 CUP - 315178
 DIAPHRAGM - 312505
 CUP - 315020

8821

Fig. 7. Old MO953 Conversion.

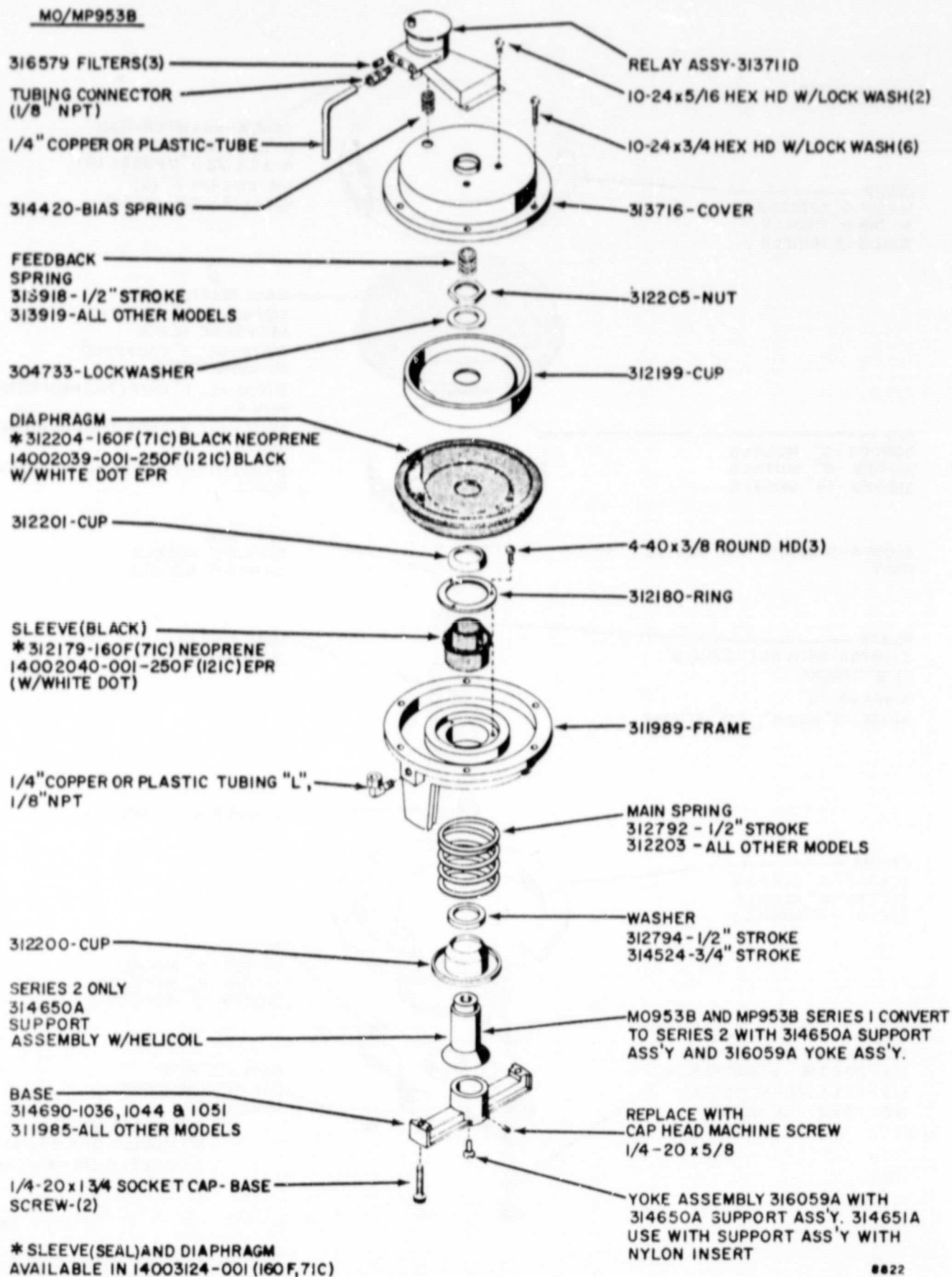
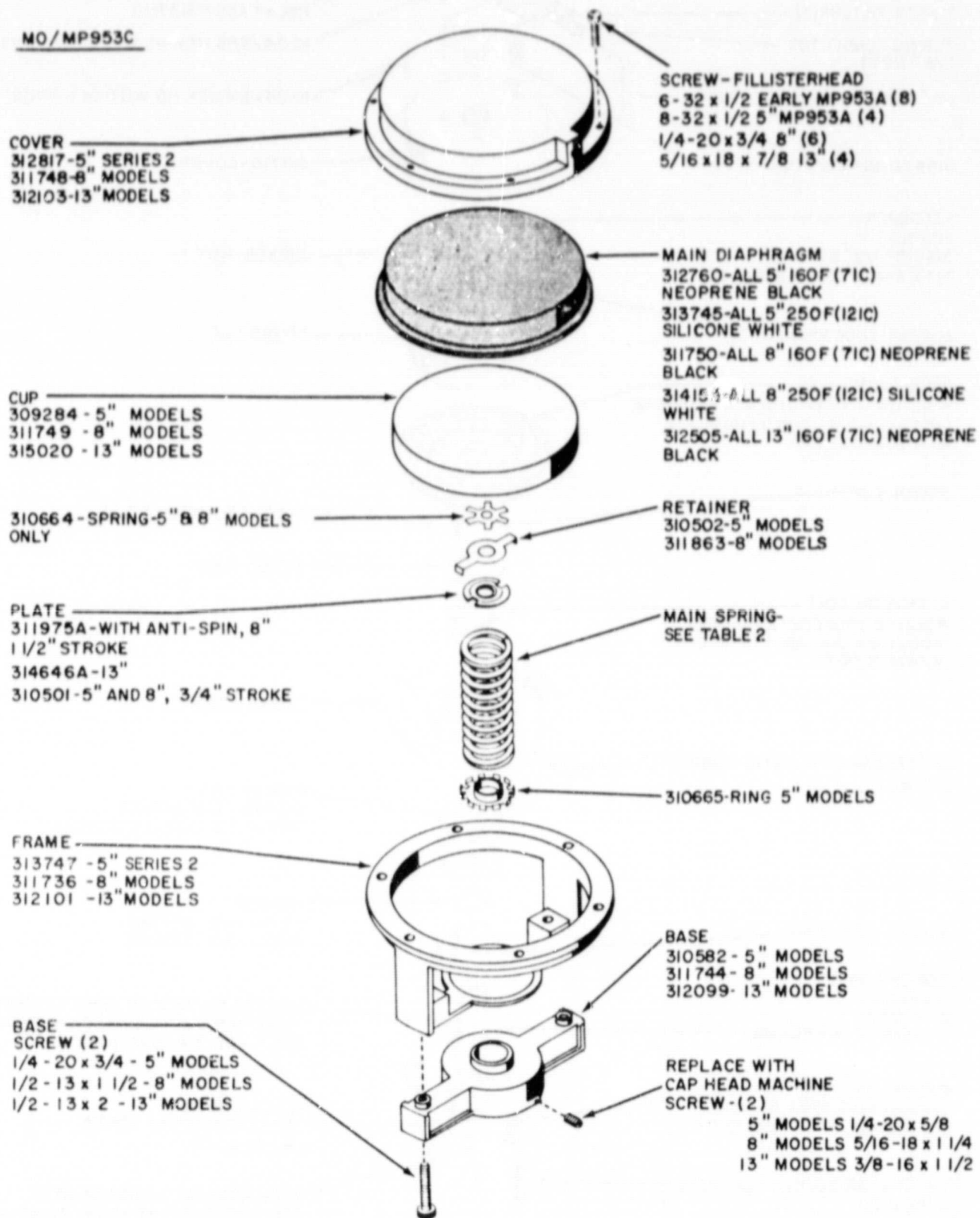


Fig. 8. Exploded View.

MO/MP953C



8823

Fig. 9. Exploded View.

75-5500

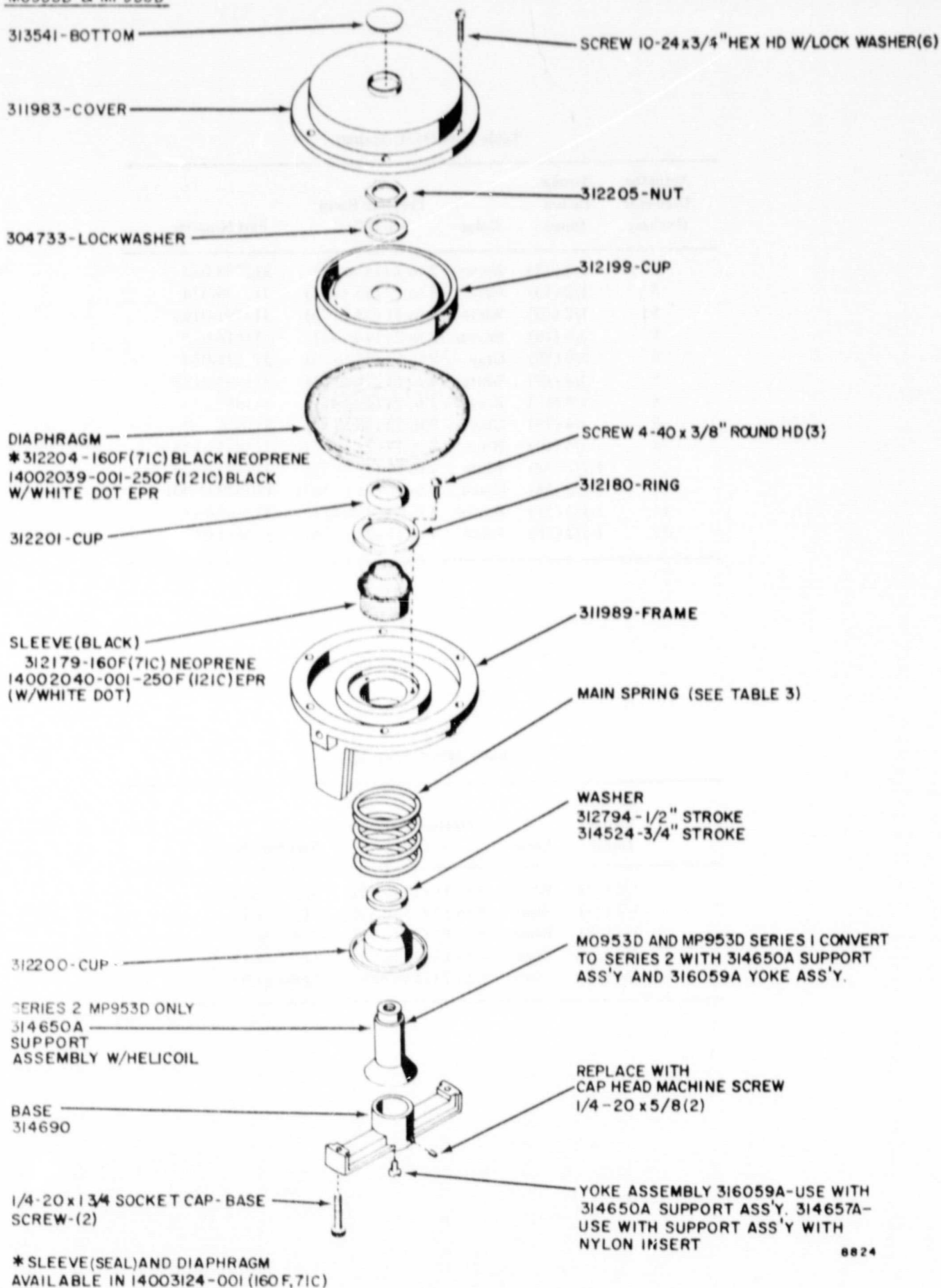
Table 2. MP953C Springs.

Actuator Diameter (Inches)	Stroke Inches (mm)	Color	Pressure Range psi (kPa)	Part Number
5	1/2 (13)	Brown	2 to 7 (14 to 48)	312788-033
5	1/2 (13)	Gray	8 to 12 (55 to 83)	312790-034
5	1/2 (13)	White	4 to 11 (28 to 76)	312791-0123
5	3/4 (19)	Brown	2 to 7 (14 to 48)	311616-033
5	3/4 (19)	Gray	8 to 12 (55 to 83)	311618-034
5	3/4 (19)	White	4 to 11 (28 to 76)	311393-0123
8	3/4 (19)	Brown	2 to 7 (14 to 48)	311852-033
8	3/4 (19)	Gray	8 to 12 (55 to 83)	311855-034
8	3/4 (19)	White	4 to 11 (28 to 76)	311854-0123
8	1-1/2 (38)	White	4 to 11 (28 to 76)	313477-0123
8	1-1/2 (38)	Green	3 to 15 (21 to 103)	14002934-001
13	1-1/2 (38)	Brown	2 to 7 (14 to 48)	312469-033
13	1-1/2 (38)	White	4 to 11 (28 to 76)	312471-0123

Table 3. MP953D Springs.

Stroke Inches (mm)	Color	Pressure Range psi (kPa)	Part Number
1/2 (13)	White	4 to 11 (28 to 76)	314314-0123
1/2 (13)	Black	8 to 13 (55 to 90)	312792-017
3/4 (19)	White	4 to 11 (28 to 76)	314313-0123
3/4 (19)	Black	8 to 13 (55 to 90)	312203-017
3/4 (19)	Silver	3 to 7 (21 to 48)	314963-605

M0953D & MP953D



8824

Fig. 10. Exploded View.

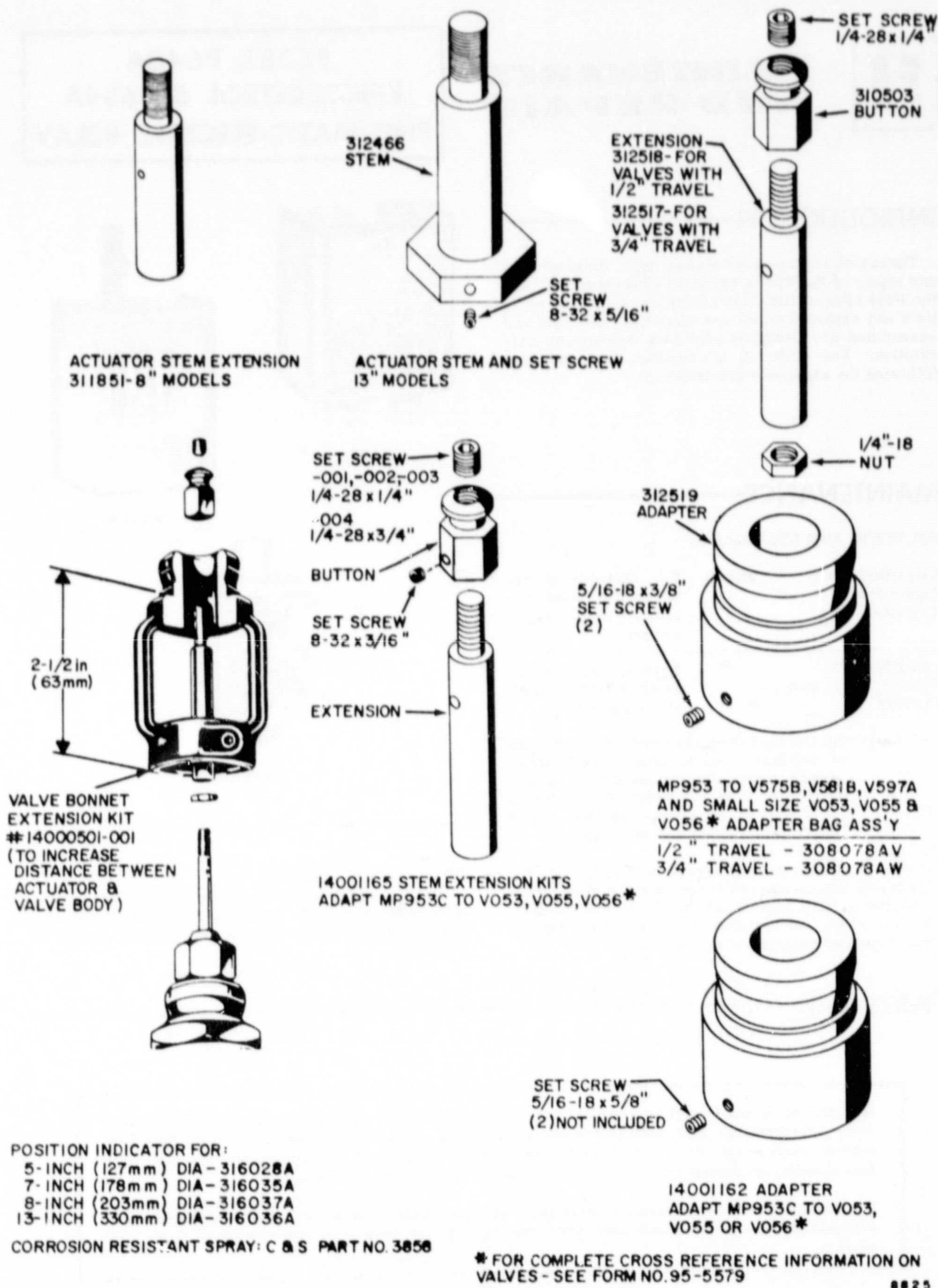


Fig. 11. MP953 Accessories.



MAINTENANCE AND REPAIR

P638A, P643A PRESSURETROL & P654A PNEUMATIC-ELECTRIC RELAY

INTRODUCTION

These instructions cover maintenance, disassembly, and repair of the P638A and P643A Pressuretrol, and the P654A Pneumatic-Electric Relay. Complete parts lists and exploded views are included. All parts and assemblies are designated by part number and description. For ordering information, see the note following the exploded view drawings.

MAINTENANCE

SOLVENTS AND LUBRICANTS

CHLOROTHENE or VYTHENE - For removal of dirt and grease. Available at most office supply houses.

LUBRIPLATE
#630AA, 3 oz. tube
#310879

To be applied to pivot points and adjustment screw threads.

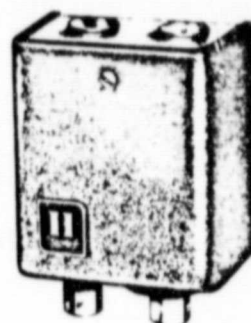
CAUTION: Special care should be exercised in the use of solvents. Have proper ventilation. Avoid prolonged inhalation and/or contact with skin; careless handling of solvents can result in permanent damage to the respiratory system and skin tissue.

Perform maintenance as required. In general, the only maintenance required is the removal of accumulated dust or dirt. Use a soft brush or blow out dirt. Use solvent to clean any grease or caked dirt. Lightly coat pivots and adjustment screw threads.

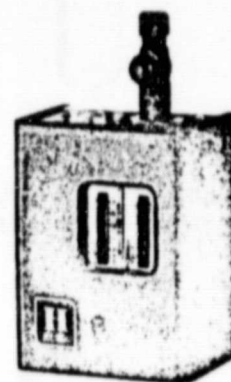
PARTS LIST

Mechanical devices must be serviced periodically if they are expected to give continuous satisfactory performance, and controls are not an exception. How accurate and how troublefree your control system will be in the years to come depends largely on the maintenance given it. For best results, all devices in your system should be serviced at one time.

Time and trouble can be saved by arranging with Honeywell for a maintenance agreement which will guarantee expert, economical care, and insure maximum life and efficiency from your system.



P638A



P643A



P654A

OPERATIONAL CHECK

A check of the units should be made with the complete system in operation. Vary the air pressure to the unit and observe that correct control action is produced.

*Trademark
5-66
L. C.

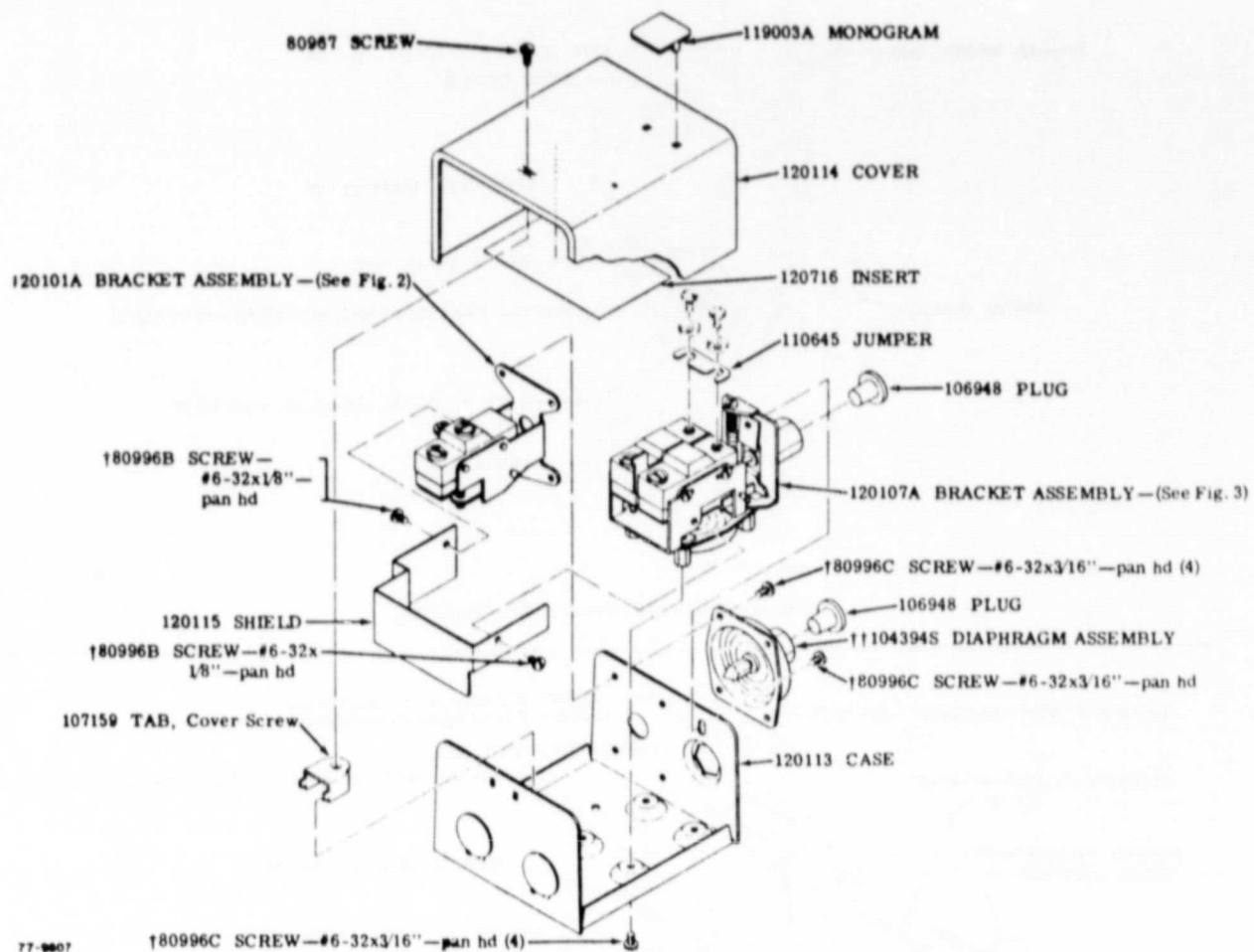


Fig. 1—P638A Pressuretrol.

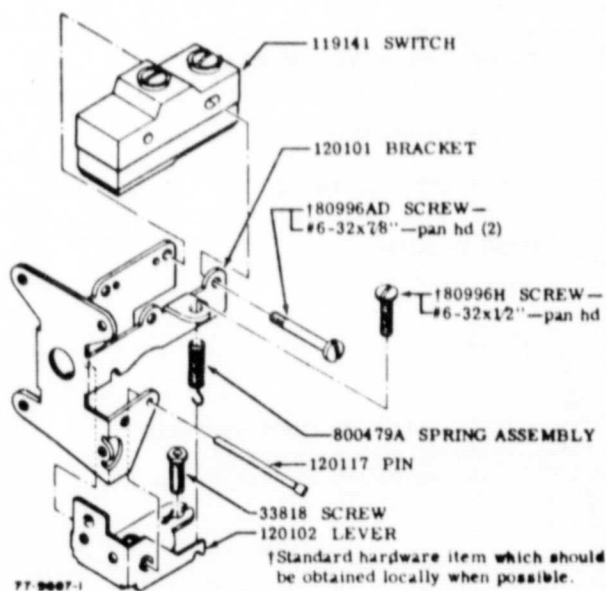


Fig. 2—Bracket Assembly (120101A).

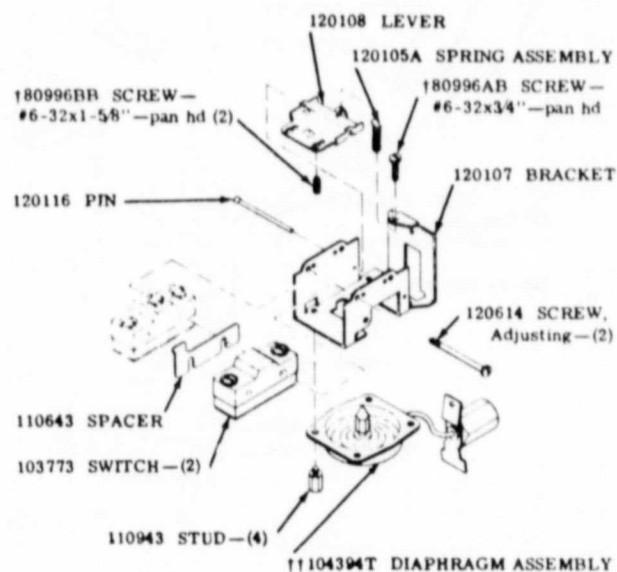


Fig. 3—Bracket Assembly—(120107A).

†Standard parts (screws, washers, electrical components, etc.) should be obtained locally when possible. Component values are subject to change without notice. Always use exact replacement parts when making repairs.
 ††Because the component parts of this assembly are staked or require a special assembly process, it is recommended that a complete replacement assembly be ordered.

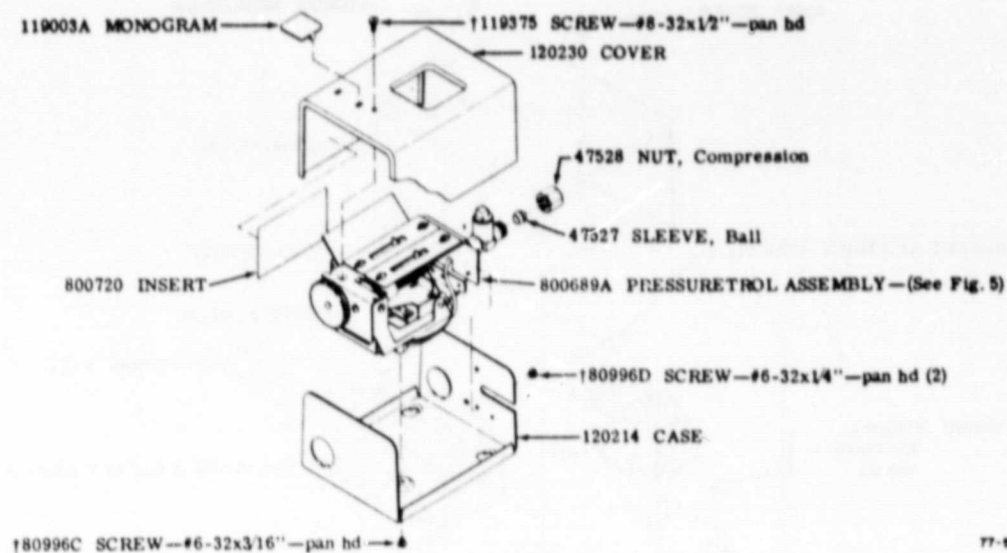


Fig. 4—P643A Pressuretrol Assembly.

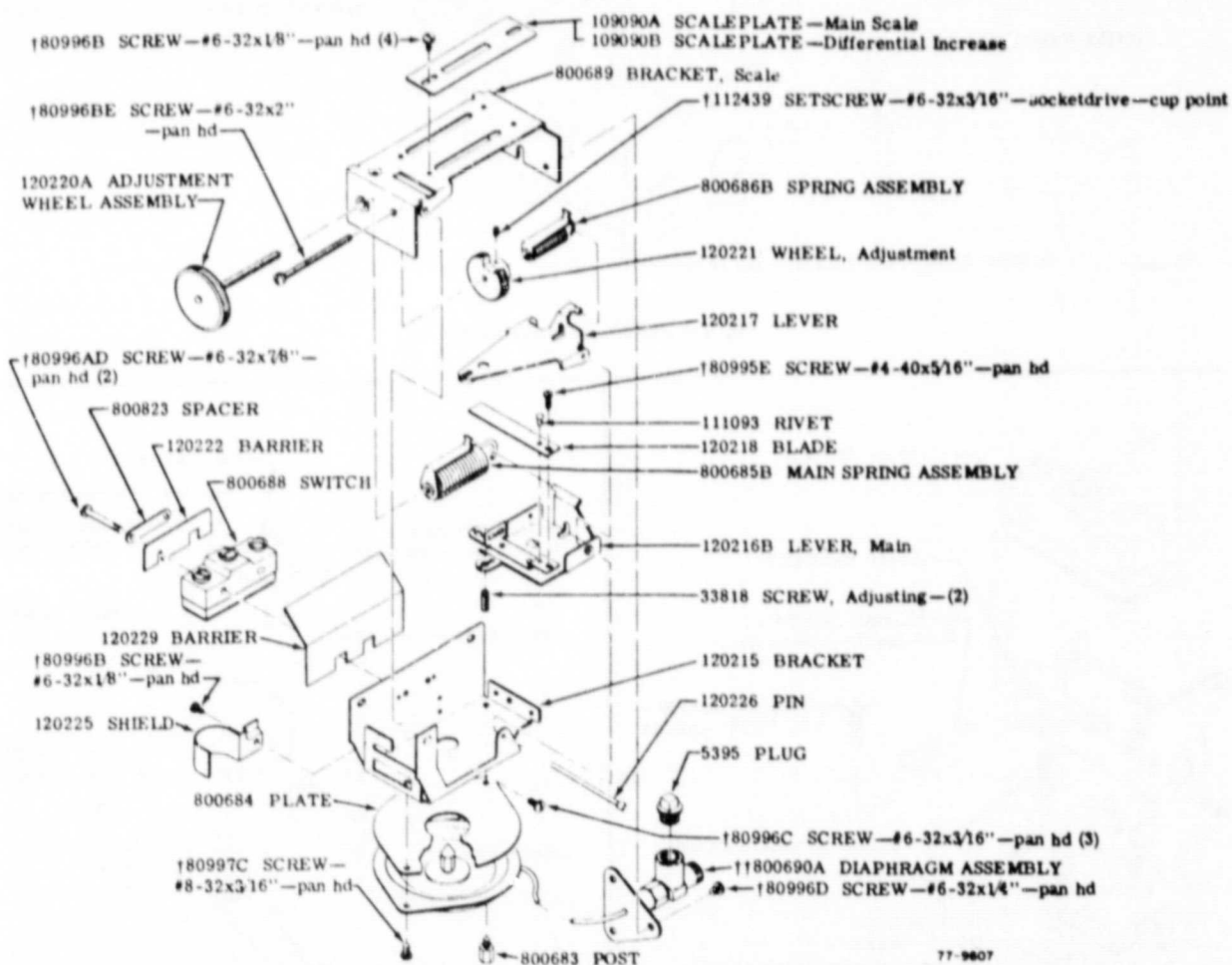
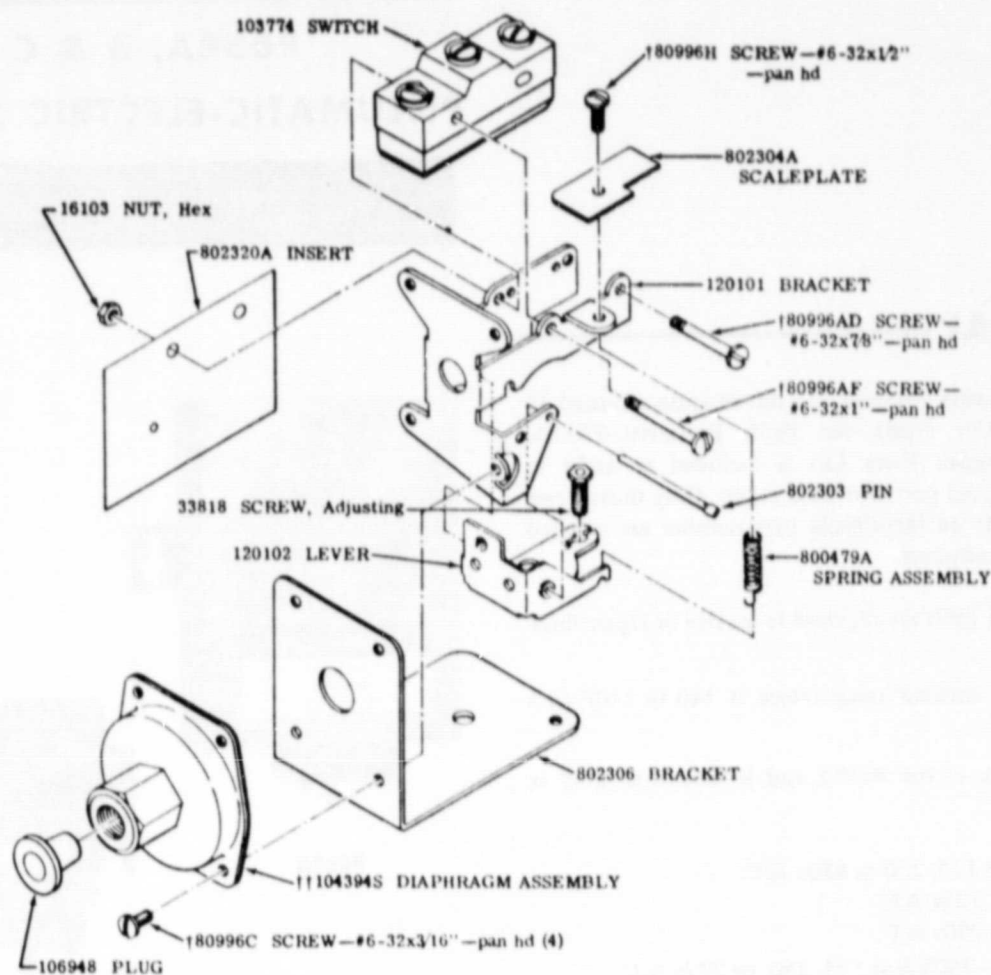


Fig. 5—Pressuretrol Assembly (800689A).

†Standard parts (screws, washers, electrical components, etc.) should be obtained locally when possible. Component values are subject to change without notice. Always use exact replacement parts when making repairs.
 ††Because the component parts of this assembly are staked or require a special assembly process, it is recommended that a complete replacement assembly be ordered.



†Standard parts (screws, washers, electrical components, etc.) should be obtained locally when possible. Component values are subject to change without notice. Always use exact replacement parts when making repairs.
 ††Because the component parts of this assembly are staked or require a special assembly process, it is recommended that a complete replacement assembly be ordered.

Fig. 6—P654A Pneumatic-Electric Relay.

ORDERING INFORMATION:

Please order by Part No. and Description. Also, give complete Order Specification number of the device. The number is stamped on case. It may be necessary to return the entire device to our factory for complete repair and reconditioning. In the U.S., orders should be mailed to Honeywell Inc., 1885 Douglas Drive, Minneapolis, Minnesota 55422. Direct all inquiries on orders to this same address. (In Canada, direct all orders and inquiries to Honeywell Controls Limited, Vanderhoof Avenue, Leaside, Toronto 17, Ontario.)

P658A, B & C

PNEUMATIC-ELECTRIC SWITCH

Service Data

GENERAL

The following includes the information required to service and/or repair the P658 Pneumatic-Electric Switch. A repair Parts List is included to assist in ordering selected parts for field repair. Only those items which include an identifying part number are stocked for ordering purposes.

No special tools are required to service or repair these devices.

Operating ambient temperature is +40 to 140F (4.5 to 60C).

The switch in the P658A and B models is rated as follows:

25 amps at 125, 250 or 480v A.C.

1 Hp at 125v A.C.

2 Hp at 250v A.C.

Pilot duty—750VA at 125, 250, or 277v A.C.

The switch used in the P658C model is for special service and is rated at 5 ma @ 5 volts.

APPLICATION

The P658 converts a pneumatic signal from a controller or other pneumatic device to a two-position electric switch action. This switching action is used to provide on/off control of fans, pumps, electric heaters, etc. found in mechanical systems.

The SPDT switch action can also be used to energize alarm systems, provide interlock functions or other pneumatic to electric interface operations.

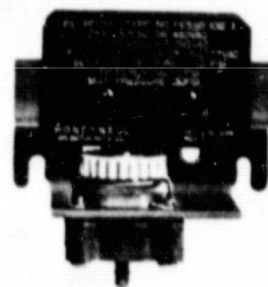
The P658C contains SPDT gold switching contacts for use in dry circuit switching and with DELTA 2000 applications.

OPERATION (See Fig. 1)

On a drop in input pressure below setpoint, the SPDT switch transfers from R-W to R-B.



P658A



P658B & C

Reverse switching (break R-B and make R-W) occurs on a pressure rise above the setpoint plus differential (2 psi [13.8 kPa]).

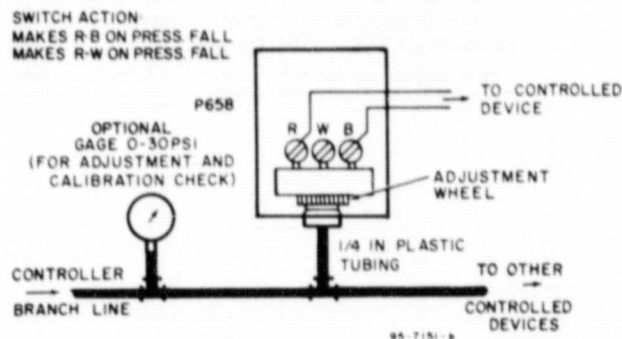


Fig. 1.

TROUBLE SHOOTING

Inspect the P658 to determine that the setpoint (factory set and marked on coverplate) is correct for the application

Increasing or decreasing the branch line pressure above or below the setpoint of the P658 should cause the switch to cycle the load. See General section for switch rating. Determine that the load connected to the switch is within the limits of the switch. Overloading will

destroy or shorten the life of the switch. If the switch is found to be defective, refer to the Repair section for replacement.

To adjust the setpoint, if required, turn the adjustment wheel (Fig. 1) clockwise (as viewed from the top looking down) to increase the setpoint; to decrease setpoint, rotate counterclockwise. One full turn of the wheel will change the setpoint 9 psig (62 kPa).

REPAIR

PARTS LIST

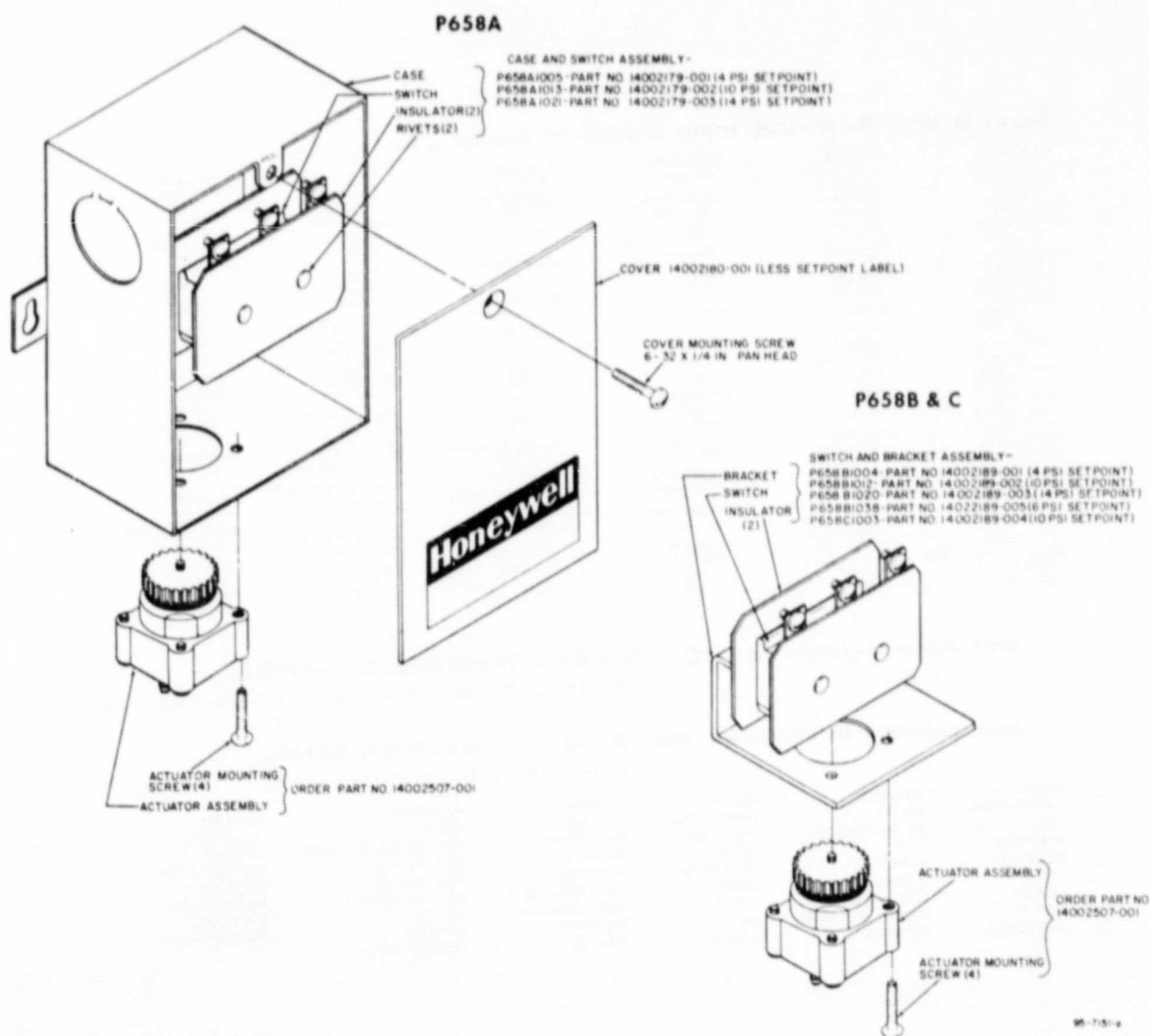


Fig. 2.

Mechanical devices must be serviced periodically if they are expected to give continued satisfactory performance, and controls are not an exception. How accurate and how troublefree your control system will be in the years to come depends largely on the maintenance given it. For best results, all devices in your system should be serviced at one time.

Time and trouble can be saved by arranging with Honeywell for a maintenance agreement which will guarantee expert, economical care, and insure maximum life and efficiency from your system.

ORDERING INFORMATION FOR HONEYWELL PARTS AND ASSEMBLIES

Contact your local Honeywell branch office for handling of repairs, pricing information and assistance. When ordering repair parts, please furnish the Part Number and Description of parts required. Also, provide the complete Order Specification Number of the device in which the parts are to be used.

SALES and SERVICE from Coast to Coast...

ALABAMA Birmingham Huntsville Mobile	FLORIDA Fort Gadsden Jacksonville Orlando Tallahassee Tampa	KENTUCKY Louisville	MONTANA Billings	NEBRASKA Omaha	NEW HAMPSHIRE Manchester	NEW JERSEY Newark Paterson	NEW MEXICO Albuquerque	NEW YORK Albany Buffalo Canton Long Island City Rochester Syracuse White Plains	NORTH CAROLINA Charlotte Greensboro	NORTH DAKOTA Fargo	OHIO Akron Cincinnati Cleveland Columbus Dayton	OKLAHOMA Oklahoma City Tulsa	OREGON Eugene Portland	PENNSYLVANIA Allentown Avoca (Scranton) Harrisburg Philadelphia Pittsburgh	PUERTO RICO San Juan	RHODE ISLAND Providence	SOUTH CAROLINA Columbia Greenville	SOUTH DAKOTA Sioux Falls	TENNESSEE Chattanooga Knoxville	TEXAS Amarillo Corpus Christi Dallas El Paso Fort Worth Houston Lubbock Odessa San Antonio	UTAH Salt Lake City	VIRGINIA Norfolk Richmond Roanoke	WASHINGTON Mercer Island (Seattle) Spokane Tacoma	WEST VIRGINIA Charleston	WISCONSIN Appleton Madison Milwaukee
ALASKA Anchorage Fairbanks	GEORGIA Atlanta	MAINE Portland	MARYLAND Baltimore (Baltimore)	MASSACHUSETTS Boston	MICHIGAN Detroit Grand Rapids Lansing Saginaw	MINNESOTA Minneapolis	MISSISSIPPI Jackson	MISSOURI Kansas City Springfield St. Louis																	

... and across Canada: HONEYWELL CONTROLS LIMITED

Head Office & Factory: 740 Ellesmere Road, Scarborough, Ontario

... and around the World: HONEYWELL INTERNATIONAL

General Offices: Minneapolis, Minn. 55408

ALGERIA	DENMARK	GUAM	KUWAIT	PANAMA	TAIWAN
ARGENTINA	EGYPT	HONG KONG	LEBANON	PERU	THAILAND
AUSTRALIA	EL SALVADOR	ICELAND	MALAYSIA	PHILIPPINE ISLANDS	TUNISIA
AUSTRIA	FIJI	INDIA	MEXICO	PORTUGAL	TRINIDAD B.W.I.
BELGIUM	FINLAND	INDONESIA	MOROCCO	SINGAPORE	TURKEY
BOLIVIA	FRANCE	IRAN	NETHERLANDS	SOUTH AFRICA	VENEZUELA
BRAZIL	GERMANY	ITALY	NEW ZEALAND	SPAIN	VIETNAM
CHILE	GREAT BRITAIN	JAPAN	NORWAY	SWEDEN	YUGOSLAVIA
COLOMBIA	GREECE	KOREA	PAKISTAN	SWITZERLAND	

Honeywell

Differential Thermostat

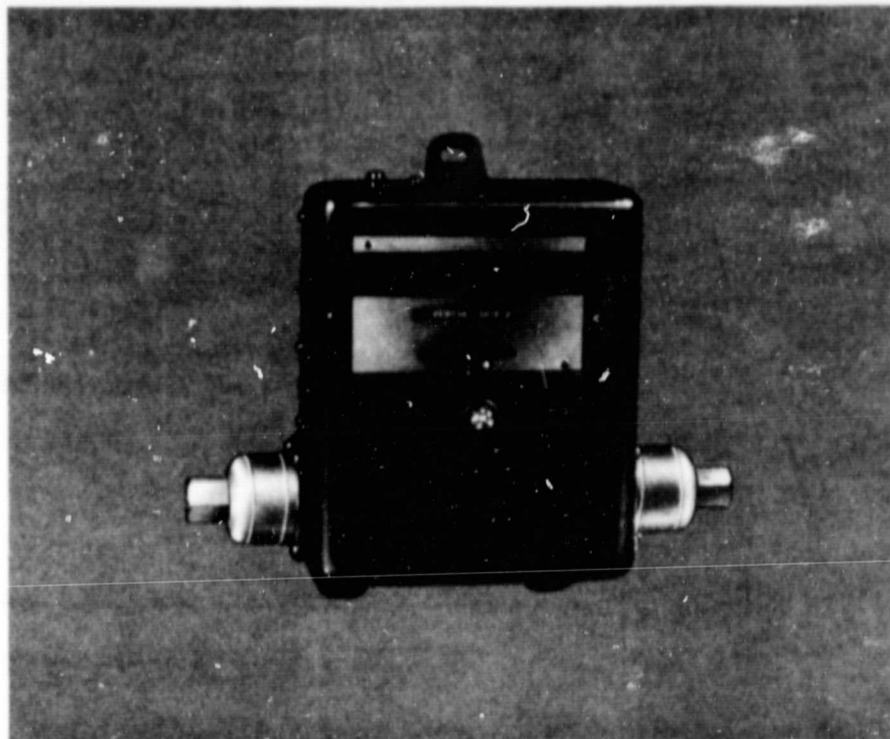
MODEL NUMBER PP903A

General

The PP903A is a pressure-operated, bleed-type, one-pipe controller for providing proportional control of pneumatic motors and valves. It varies the air pressure piped to it in relation to the difference in pressure existing between water pressures.

Features

- Direct or reverse-acting. Change-over link provides quick and easy change-over from direct to reverse-acting.
- Easily accessible adjustment means for throttling range and pressure range.
- Mounting lugs for quick and easy mounting.



Specifications

MODEL
PP903A

TABLE 1. PP903A SPECIFICATIONS

Pressure Difference Setpoint Range*	Operating Pressure Limits of Bellows Assemblies		Approximate Throttling Range of Controller at:					
			Low End of Scale		Mid Scale		High End of Scale	
	Min	Max.	Min	Max.	Min	Max.	Min	Max.
0-22 psi (0-152 kPa)	22 Hg vac	85 psi (586 kPa)	-----	-----	6 oz. (2/5 kPa)	26 oz. (11 kPa)	-----	-----
3-50 psi (21-344 kPa)	2 psi (14 kPa)	85 psi (586 kPa)	1.5 psi (10 kPa)	11 psi (76 kPa)	3 psi (21 kPa)	16 psi (110 kPa)	4 psi (28 kPa)	22 psi (152 kPa)
5-65 psi (35-448 kPa)	0 psi	300 psi (2068 kPa)	6 psi (41 kPa)	30 psi (217 kPa)	-----	-----	9 psi (62 kPa)	30 psi (207 kPa)

*A blank scale is provided to permit the controller to be calibrated to individual installations in the field.

MAXIMUM SAFE AIR PRESSURE

18 psi (124 kPa)

ADJUSTMENT MEANS

External slotted screws for throttling range and pressure range.

TYPE OF ELEMENT

Bellows

AIR CONNECTIONS

1/2 NPT

PRESSURE CONNECTION TO BELLOWS

1/4 NPT

MOUNTING

Lugs for three-point surface mounting.

DIMENSIONS

See Figure 1.

FINISH

Gray

ACCESSORIES

.007 Restriction.

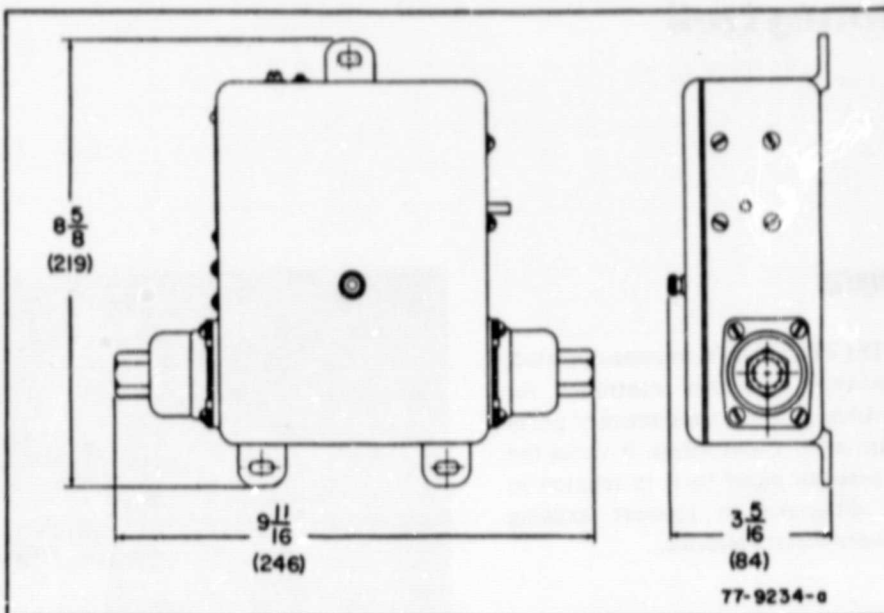
WHEN ORDERING, SPECIFYPressure difference range.
Accessories.

FIG. 1. PP903A APPROXIMATE DIMENSIONS IN INCHES (MILLIMETERS)

Typical Operation

Either an increase in supply pressure or a decrease in return pressure will increase the differential pressure across the system. On an increase in differential pressure, the PP903, when set direct-acting, will increase the branch line pressure closing a normally-open valve just enough to return the system differential to its setpoint value.

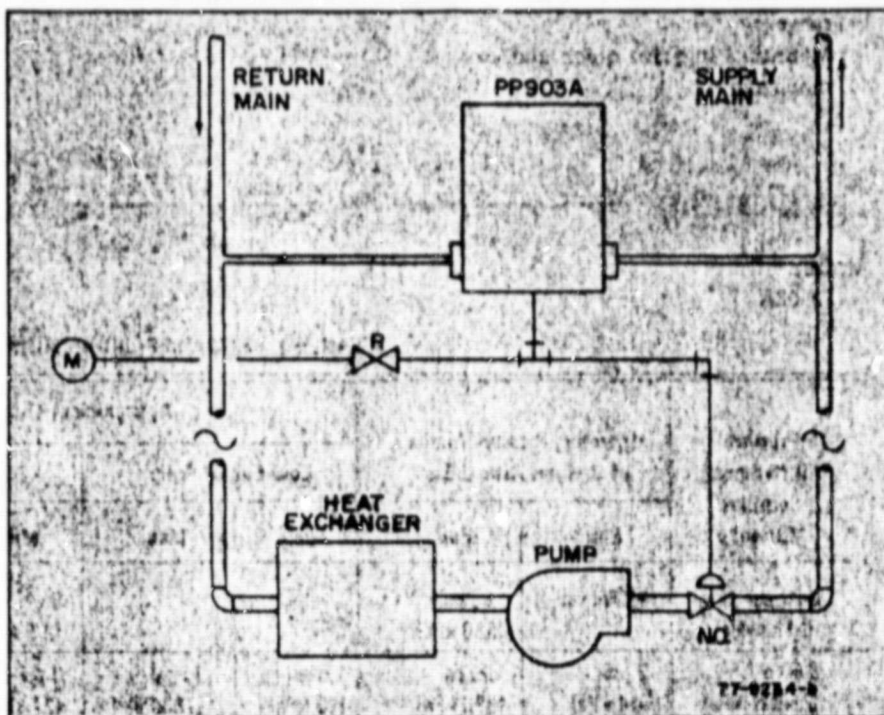


FIG. 2. PP903A TYPICAL OPERATION

Honeywell

THESE RELAYS PROVIDE INTERMEDIATE OR HEAVY DUTY SERVICE IN A WIDE VARIETY OF SWITCHING CONFIGURATIONS.

□ Relays with 24V control coils: R182A-C; R882A-C,F; R847A,B; RA19A; RA89A; RA832A; R845A.

□ Relays with line voltage control coils: R447A; R482A-E.

□ Relays with internal 24V transformer: R182A-C; RA19A; RA89A; RA832A; R845A; R847A.

□ Relays for use with an external 24V supply: R847B; R882A-C,F.

□ Heavy duty relays: R447A; R847A,B.

□ R447A and R847A,B have flexible internal leads to provide either spst or spdt switching.

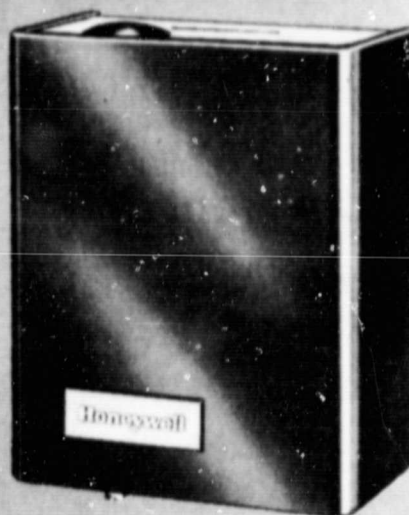
□ RA832A has contacts for low voltage and millivoltage (Powerpile) use.

□ R882F is suitable for use as an emergency heat relay with a heat pump panel.

□ R482E switches electronic bridge circuit elements.

H.K.
8-79 (.16)

SWITCHING RELAYS



RA19A; RA89A;
R182A-C; R447A;
R482A-E; RA832A;
R845A; R847A,B;
R882A-C,F

Form Number

60-2481

SPECIFICATIONS

IMPORTANT

THE SPECIFICATIONS GIVEN IN THIS PUBLICATION DO NOT INCLUDE NORMAL MANUFACTURING TOLERANCES. THEREFORE, THIS UNIT MAY NOT MATCH THE LISTED SPECIFICATIONS EXACTLY. ALSO, THIS PRODUCT IS TESTED AND CALIBRATED UNDER CLOSELY CONTROLLED CONDITIONS, AND SOME MINOR DIFFERENCES IN PERFORMANCE CAN BE EXPECTED IF THOSE CONDITIONS ARE CHANGED.

TRADELINE MODELS

TRADELINE models are selected and packaged to provide ease of stocking, ease of handling, and maximum replacement value. TRADELINE model specifications are the same as those of standard models except as noted below.

TRADELINE MODEL AVAILABLE:

R182C-120 and 240V models.
R482C-120 and 240V models.
RA89A-24V controller.

ADDITIONAL FEATURES:

TRADELINE pack with cross reference label and special instruction sheet.

STANDARD MODELS

MODELS: Refer to Tables I-V.

(continued on page 3)

ORDERING INFORMATION

WHEN PURCHASING REPLACEMENT AND MODERNIZATION PRODUCTS FROM YOUR TRADELINE WHOLESALE OR YOUR DISTRIBUTOR, REFER TO THE TRADELINE CATALOG OR PRICE SHEETS FOR COMPLETE ORDERING NUMBER, OR SPECIFY—

1. Order number.
2. Voltage and frequency.
3. Optional specifications desired.

IF YOU HAVE ADDITIONAL QUESTIONS, NEED FURTHER INFORMATION, OR WOULD LIKE TO COMMENT ON OUR PRODUCTS OR SERVICES, PLEASE WRITE OR PHONE:

1. YOUR LOCAL HONEYWELL RESIDENTIAL DIVISION SALES OFFICE (CHECK WHITE PAGES OF PHONE DIRECTORY).

2. RESIDENTIAL DIVISION CUSTOMER SERVICE
HONEYWELL INC., 1885 DOUGLAS DRIVE NORTH
MINNEAPOLIS, MINNESOTA 55422 (612) 542-7500

(IN CANADA—HONEYWELL CONTROLS LIMITED, 740 ELLESMERE ROAD, SCARBOROUGH, ONTARIO M1P 2V9)
INTERNATIONAL SALES AND SERVICE OFFICES IN ALL PRINCIPAL CITIES OF THE WORLD.

**TABLE I—
ELECTRICAL CONTACT RATINGS (AMPERES)**

MODEL	120V ac			240V ac		
	FULL LOAD	LOCKED ROTOR	RESISTIVE	FULL LOAD	LOCKED ROTOR	RESISTIVE
R182A	10.2	61.2	—	5.1	30.6	—
R182B,C R882B,C	7.4	44.4	—	3.7	22.2	—
R482A R882A	7.4	44.4	10	4.5	27.0	6
R482B,C	7.2	43.2	10	3.6	21.6	5
R482D	4.4	26.4	5	2.2	13.3	3
R482E ^a	0.2	0.4	—	0.1	0.2	—
RA19A RA89A	10.0	60.0	10	6.5	39.0	6
RA832A ^{d,f} R845A ^{e,f}	7.4	44.4	72/100 ^c	4.5	27.0	6
R447A R847A,B ^b 60 Hz Only R882F	16/22 ^c	72/100 ^c	—	16/22 ^c	72/100 ^c	—
125 VA pilot duty at 120V and 240V; 3 amp full load at 24V ac.						

^a24V rating of 1 amp full load and 2 amp locked rotor.

^bR847B rated at 208V.

^cRating if poles are paralleled.

^dIncludes contact for switching additional low or millivoltage (Powerpile) load.

Millivoltage Rating: 300 ma minimum at 750 mV dc.

Low Voltage Rating:

Pilot duty—50 VA at 24V.

Direct current rating—1 amp at 12V.

^eSecond set of contacts rated for line or low voltage load.

120V—3 amp full load, 18 amp locked rotor.

240V—2 amp full load, 12 amp locked rotor.

50 VA at 24V.

^fMaximum Connected Load: 2000 VA.

TABLE II—COIL DATA

MODEL	COIL VOLTAGE 50/60 Hz	COIL CURRENT (AMPS)	SEALED VA		INRUSH VA		MAX-PULL IN VOLT
RA19A ^a	24	0.40					20
RA89A	24	0.40					20
R182A,B ^a R182C ^a	24	0.40 0.35					20
R447A	120 240	0.04 0.02	8.9	17.4 17.7			85 180
R482A/B-E	120 240	0.04 0.02	0.07 0.04	4.8 5.3	8.6 10.2	9.4 22.2	80 180
R832A ^a	24	0.40					20
R845A ^a	24	0.40					20
R847A ^a	24	0.35	8.4			21.4	20
R847B ^b		0.42					
R882A,B ^b R882C ^b R882F ^b	24	0.21 0.42 0.40	5.2 5.2 9.4			9.4 9.4 20.6	20

^aBuilt-in low voltage (24V) transformer.

^bRequires external 24V transformer.

TABLE III—TRANSFORMER RATINGS

Ratings of built-in transformers are as follows: All transformers are rated at 120/240V, 50/60 Hz.

R847A	7.0 watts
RA19A, RA89A	5.0 watts
RA832A	
R845A	
R182A-C	6.5 watts

TABLE IV—SWITCHING ACTION

SWITCHING	MODEL
Spst	RA19A, RA89A, R182A, R482A, R882A,F ^c
Spdt	R182B, R482E, R882B
Dpst	R447A, R847A,B, RA832A ^a , R845A
Dpdt	R182C, R482C,E, R842D ^b , R882C

^a Low/millivoltage circuit spst.

^b N.O. contacts make before N.C. contacts break;
N.C. contacts make before N.O. contacts break.

^c 1 single-throw branch.

FINISH: Gray enamel.

KNOCKOUTS:

Case bottom—(2) RA19A, RA89A, RA832A, R845A;

(3) R182A-C, R482A-E, R882A-C,F.

All models have 1 wiring hole in case top.

All knockouts are for 1/2 inch [12.7 mm] conduit.

APPROVALS:

UNDERWRITERS LABORATORIES INC. listed:

RA19A; RA89A; RA832A, R882A-C,F; R845A—

File No. E4436, Guide No. XAPX; R482A-D—

File No. E14480, Guide No. NLDX; R447A;

R847A,B—File No. SA481, Guide No. SDFY.

CANADIAN STANDARDS ASSOCIATION certified:

R482A-D; R882A-C; R447A; R847A,B: File No.

LR1620.

OPTIONAL SPECIFICATIONS:

R845A—available without electrical barrier between terminals 2 and 4, and 5 and 6. For switching two equal line voltage loads.

R482A—available with fungus proofing, 60 Hz only.

R482B—available with 24V coil.

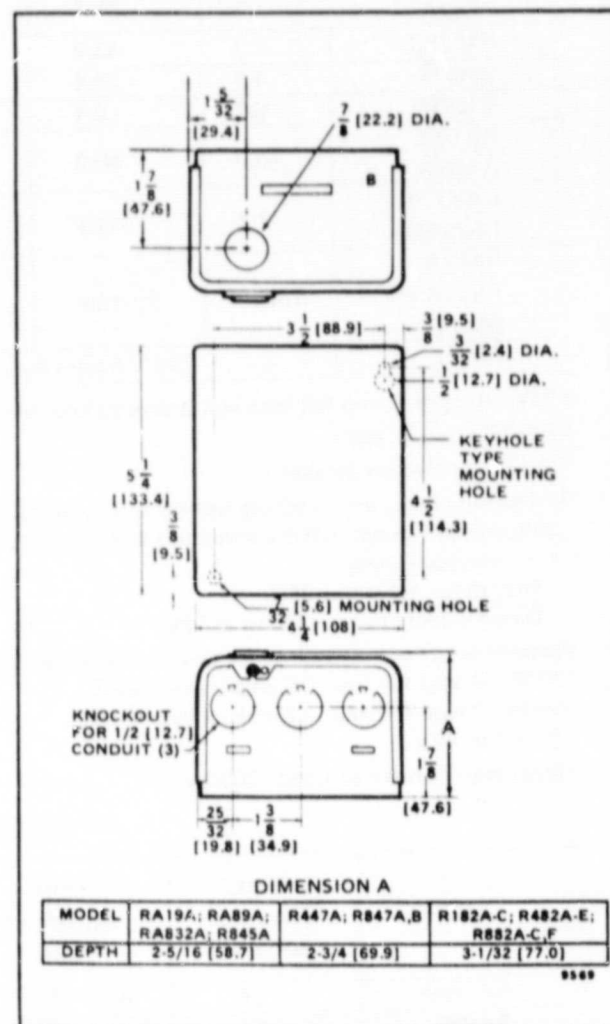


FIG. 1—APPROXIMATE MOUNTING DIMENSIONS [MILLIMETRES IN BRACKETS].

INSTALLATION

WHEN INSTALLING THIS PRODUCT...

1. Read these instructions carefully. Failure to follow them could damage the product or cause a hazardous condition.

2. Check the ratings given in the instructions and on the product to make sure the product is suitable for your application.

3. Installer must be a trained, experienced service technician.

4. After installation is complete, check out product operation as provided in these instructions.

CAUTION

Disconnect the power supply before beginning wiring to prevent electrical shock and equipment damage.

MOUNTING

For replacement, mount relay in same location as old control. If a new installation, locate the relay vertically on a solid wall or partition as near as possible the device to be controlled. Select a location that is easily accessible for installation and service.

NOTE: To reduce possible transformer hum and relay noise that is sometimes amplified by mounting surfaces of sheetmetal, plasterboard, and similar materials, place rubber or felt washers between case and the mounting surface.

1. Position relay and mark mounting holes.
2. Start a screw for the keyhole type mounting hole in upper right-hand corner. Screw it down within about 1/8 inch [3.2 mm] of the surface.
3. Hang the relay on the screw, position the case, and start the bottom screw; tighten both screws.

WIRING

IMPORTANT

The terminals on these switching relays are approved for use with copper wires only.

All wiring must comply with all applicable electrical codes, ordinances, and regulations. Follow any instructions furnished with the controlled equipment.

Hookup diagrams for these relays are included. If two or more devices are to be controlled in parallel, their total current must not exceed the relay load rating.

IMPORTANT

The transformer on the R182C may overheat when used with a series 20 thermostat if the total resistance of the thermostat circuit exceeds 2.5 ohms. If the measured resistance of the thermostat (including thermostat wire and thermostat contact resistance) exceeds 2.5 ohms, add a 100 ohm, 10 watt resistor between the W and R terminals. Table V gives maximum thermostat wire runs; if longer runs are necessary, measure the resistance or add a 100 ohm, 10 watt resistor across terminals W and R.

TABLE V

AWG WIRE SIZE (NUMBER)	TOTAL WIRE LENGTH		LENGTH OF RUN TO THERMOSTAT (2 WIRES)	
	FEET	METRES	FEET	METRES
22	120	38	60	18
20	200	61	100	30.5
18	300	91.5	150	45.5
16	500	152.5	250	76
14	800	244	400	122

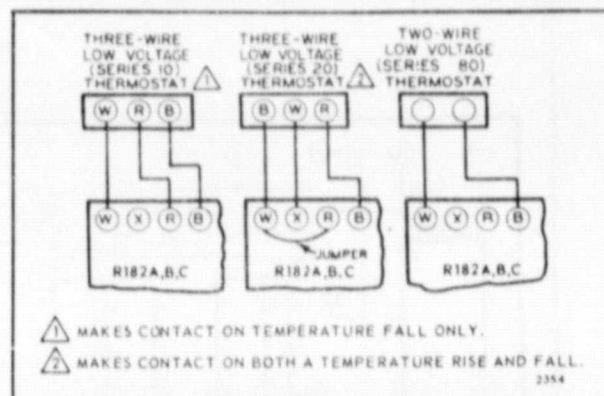


FIG. 2—THERMOSTAT CONNECTIONS FOR R182A-C RELAYS.

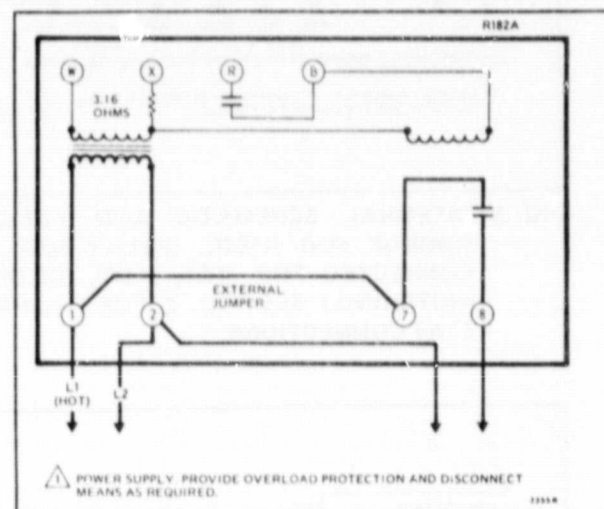


FIG. 3—INTERNAL SCHEMATIC AND TYPICAL HOOKUP FOR R182A. SEE FIG. 2 FOR THERMOSTAT CONNECTIONS.

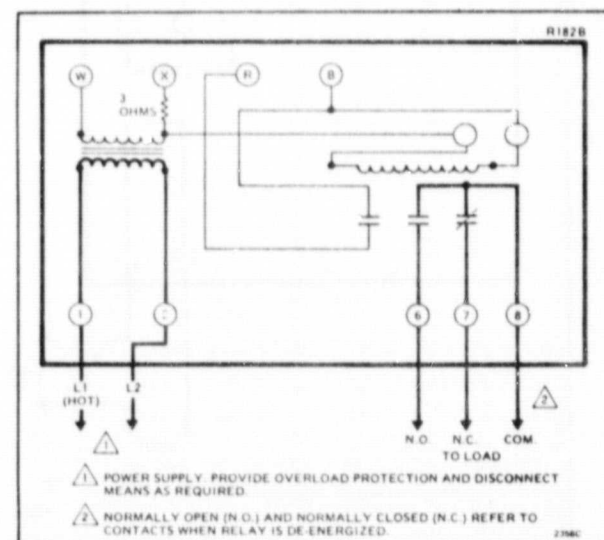


FIG. 4—INTERNAL SCHEMATIC AND TYPICAL HOOKUP FOR R182B. (RELAY MAY BE CONNECTED FOR SPST SWITCHING.) SEE FIG. 2 FOR THERMOSTAT CONNECTIONS.

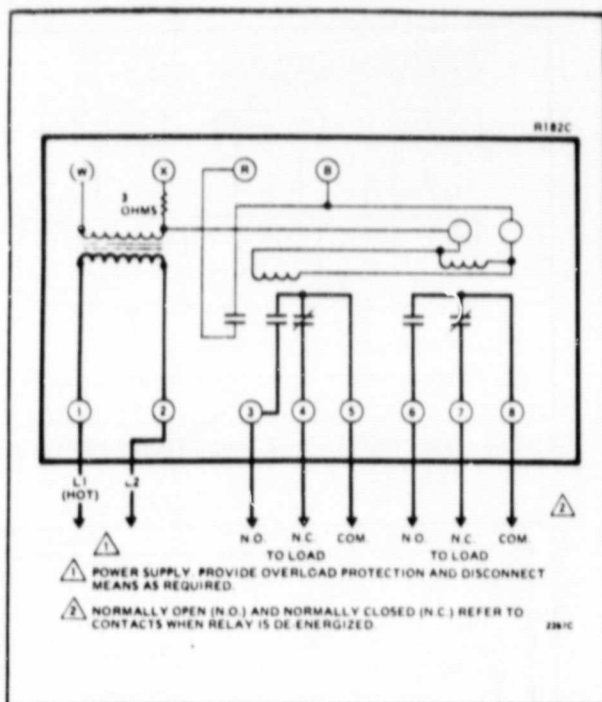


FIG. 5—INTERNAL SCHEMATIC AND TYPICAL HOOKUP FOR R182C. (RELAY MAY BE CONNECTED FOR SPST, SPDT, OR DPST SWITCHING.) SEE FIG. 2 FOR THERMOSTAT CONNECTIONS.

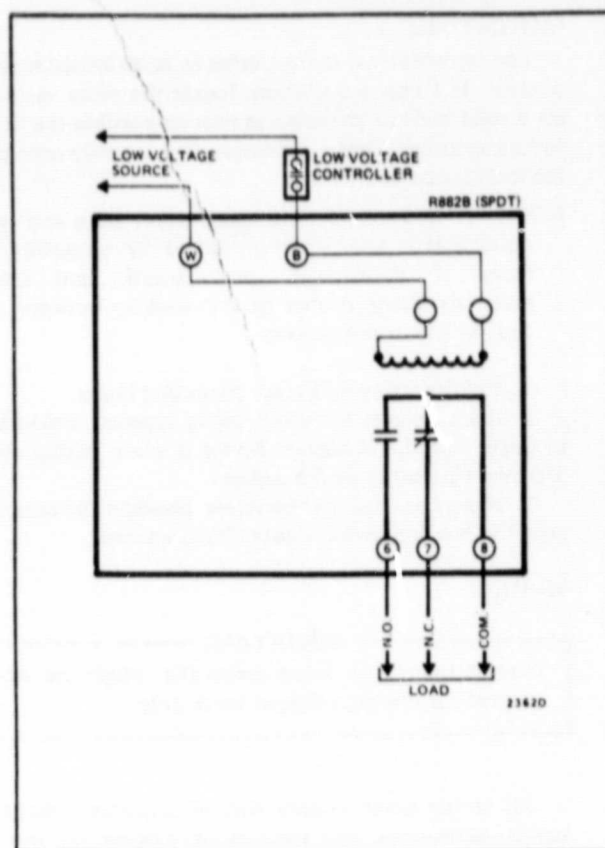


FIG. 7—INTERNAL SCHEMATIC AND TYPICAL HOOKUP FOR R882B.

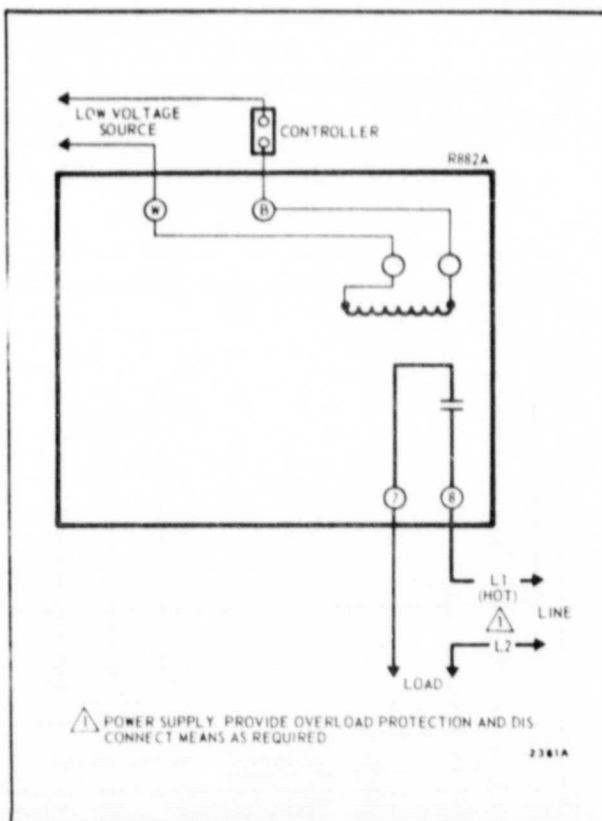


FIG. 6—INTERNAL SCHEMATIC AND TYPICAL HOOKUP FOR R882A.

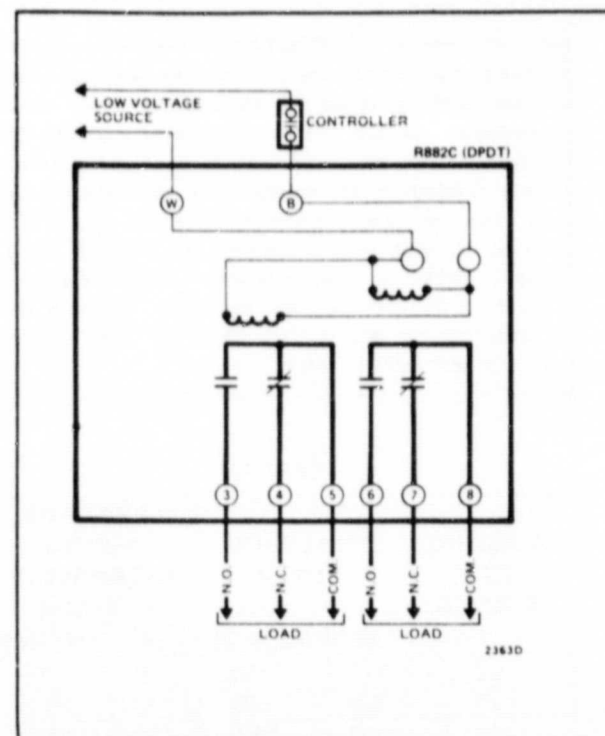


FIG. 8—INTERNAL SCHEMATIC AND TYPICAL HOOKUP FOR R882C.

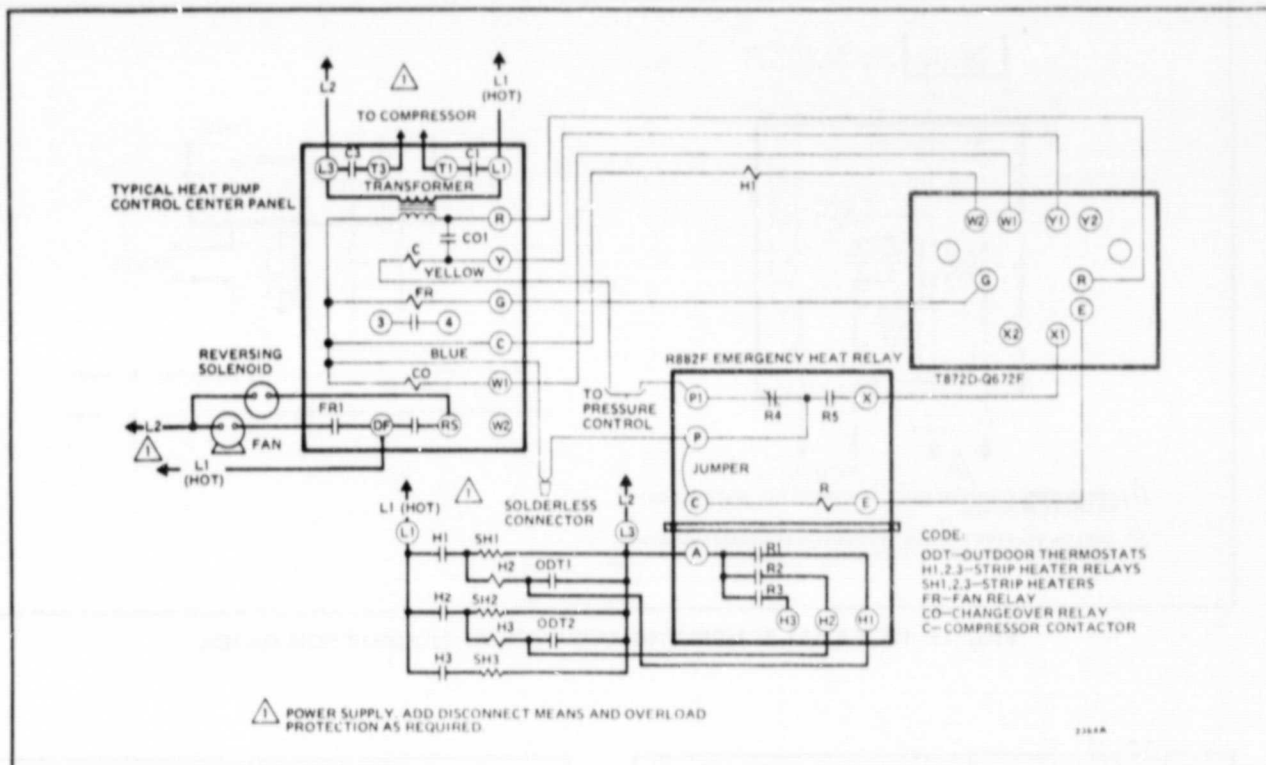


FIG. 9—R882F EMERGENCY HEAT RELAY USED WITH HEAT PUMP PANEL (WITHOUT IMPEDANCE RELAY). AUXILIARY STRIP HEATER RELAY NO. 1 IS POWERED FROM THE LOW VOLTAGE HEAT PUMP PANEL CIRCUIT. STRIP HEATER RELAYS 2 AND 3 ARE POWERED FROM A SEPARATE LINE VOLTAGE SOURCE.

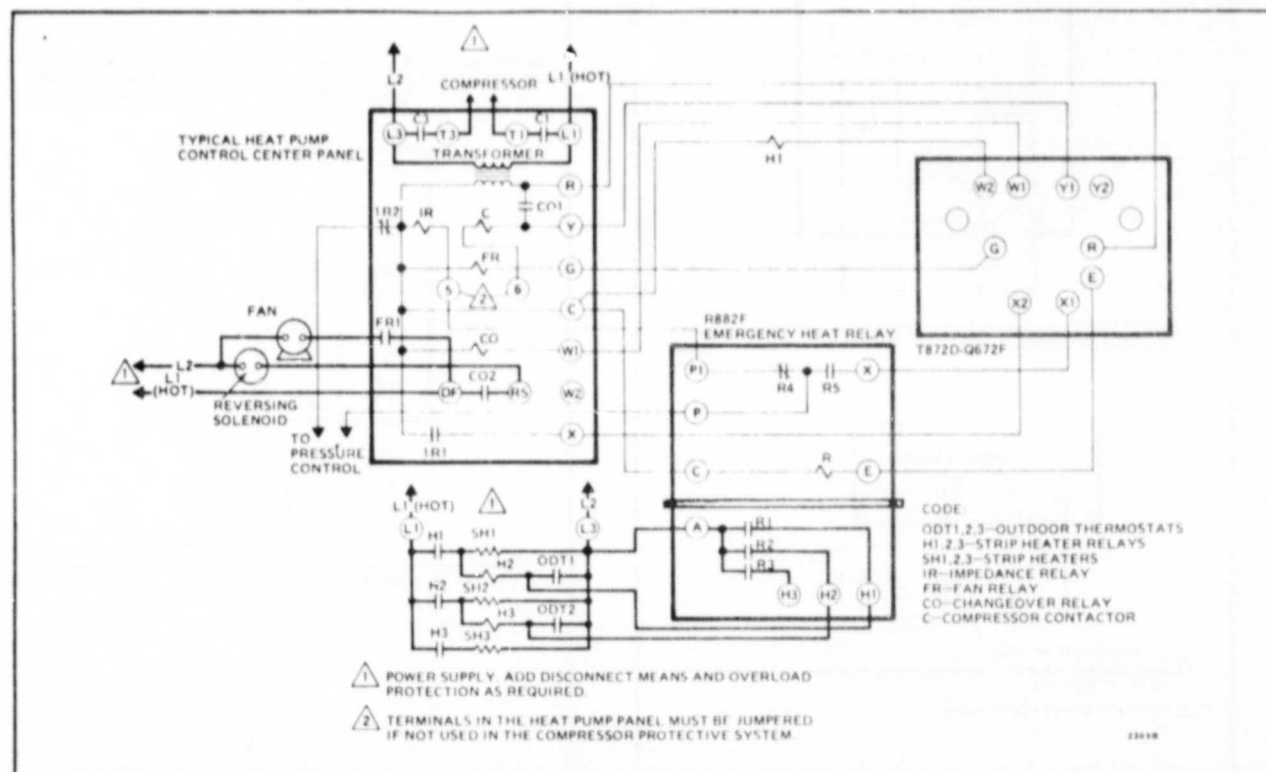


FIG. 10—R882F EMERGENCY HEAT RELAY USED WITH HEAT PUMP PANEL (WITH IMPEDANCE RELAY). AUXILIARY STRIP HEATER RELAY NO. 1 IS POWERED FROM THE LOW VOLTAGE HEAT PUMP PANEL CIRCUIT.

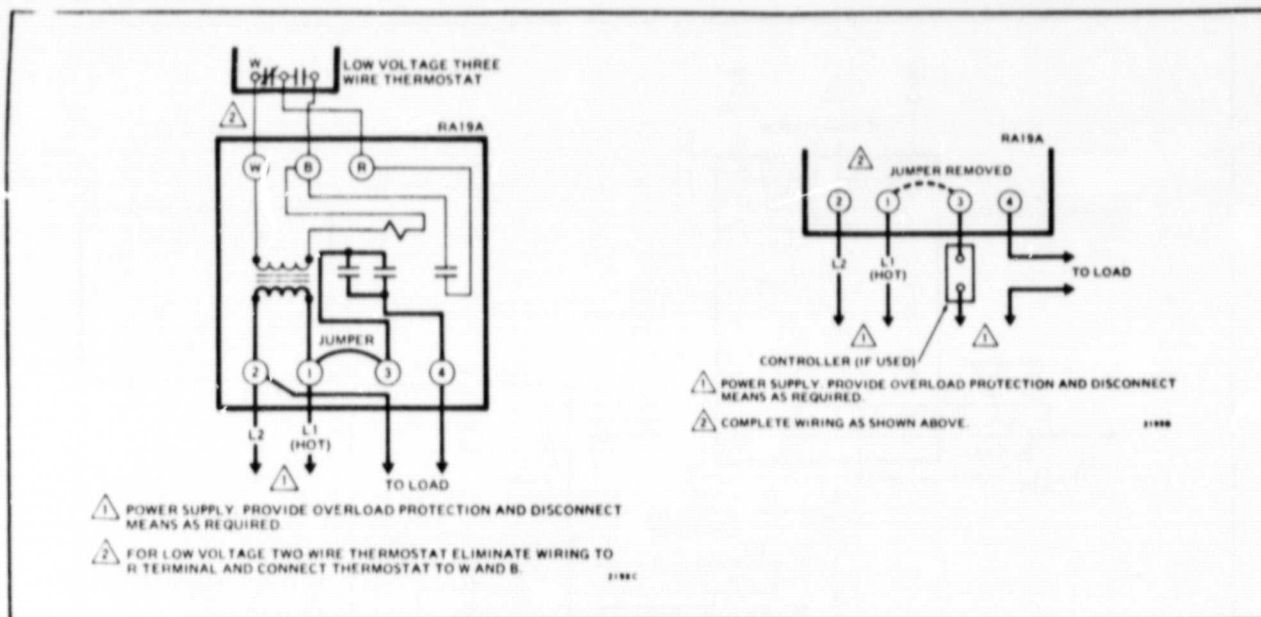


FIG. 11—INTERNAL SCHEMATIC AND TYPICAL HOOKUP FOR RA19A.

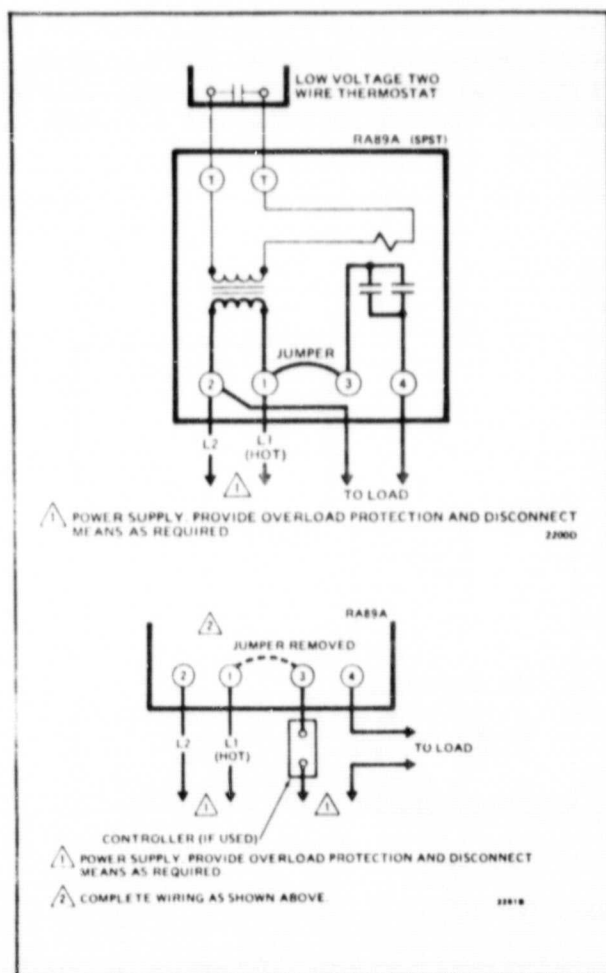


FIG. 12—INTERNAL SCHEMATIC AND TYPICAL HOOKUP FOR RA89A.

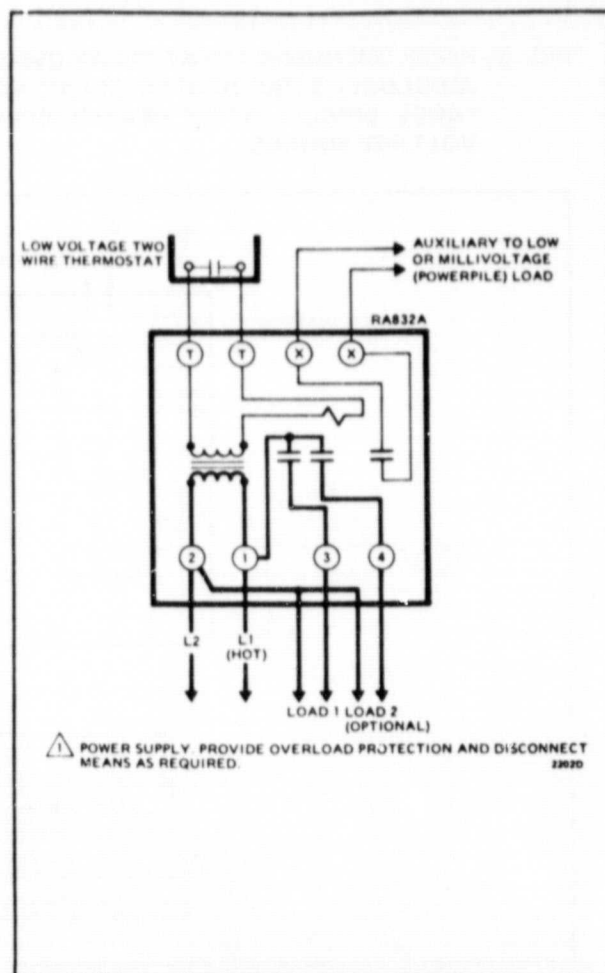


FIG. 13—INTERNAL SCHEMATIC AND TYPICAL HOOKUP FOR RA832A.

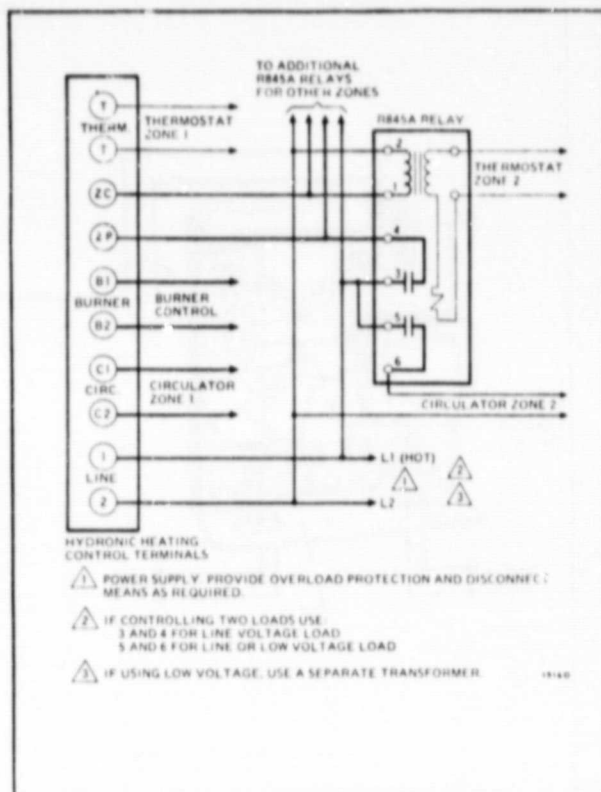


FIG. 14—SCHEMATIC DIAGRAM SHOWING R845A IN A MULTIZONE, FORCED HYDRONIC HEATING SYSTEM. THIS ARRANGEMENT IS SUITABLE FOR ANY NUMBER OF ADDITIONAL ZONES.

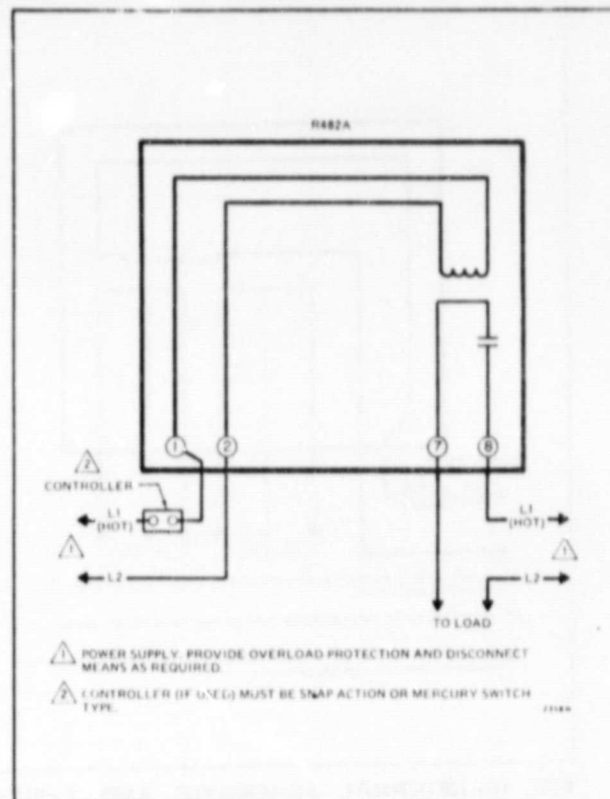


FIG. 16—INTERNAL SCHEMATIC AND TYPICAL HOOKUP FOR R482A.

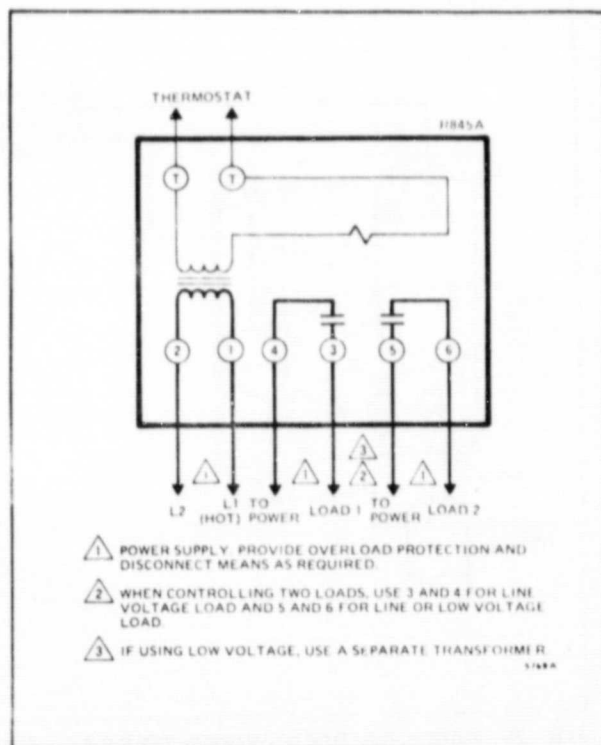


FIG. 15—R845A HOOKUP FOR CONTROLLING 2 LOADS.

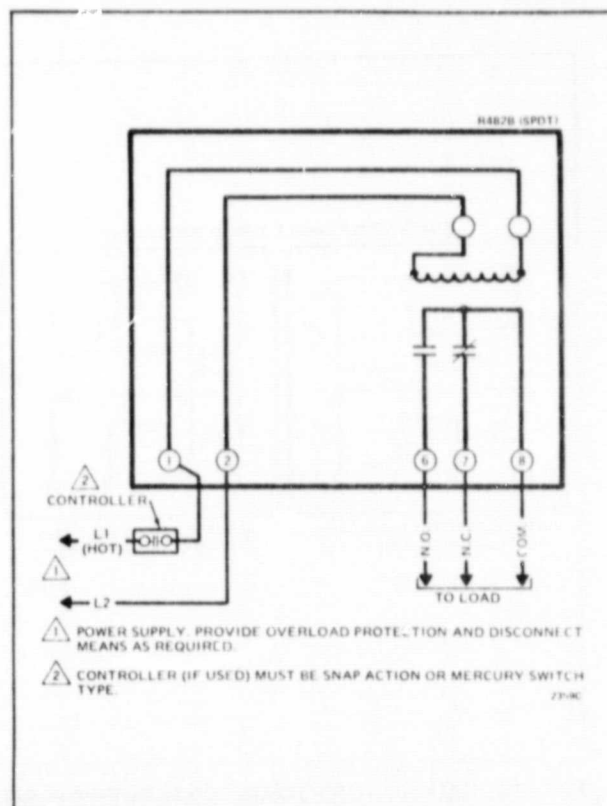


FIG. 17—INTERNAL SCHEMATIC AND TYPICAL HOOKUP FOR R482B.

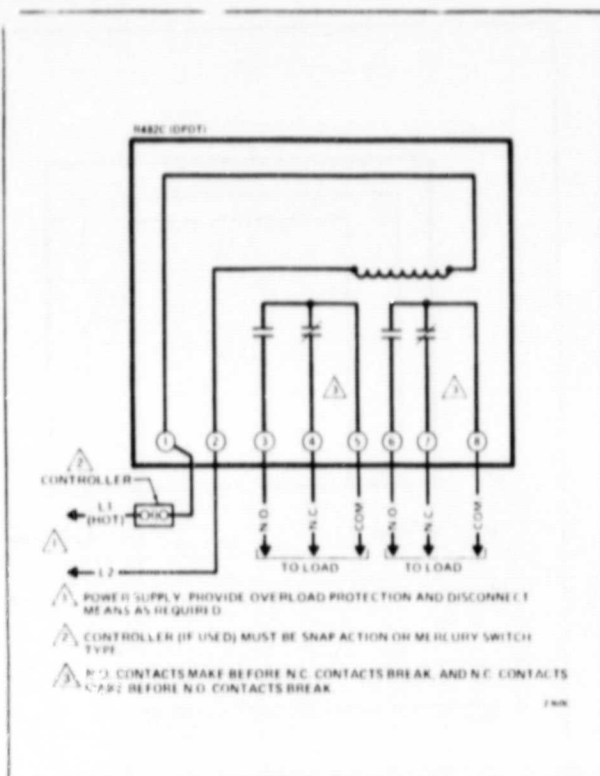


FIG. 18—INTERNAL SCHEMATIC AND TYPICAL HOOKUP FOR R482C. R482D IS THE SAME WITH THE EXCEPTION OF OVERLAPPING RELAY CONTACTS AND CONTACT RATING.

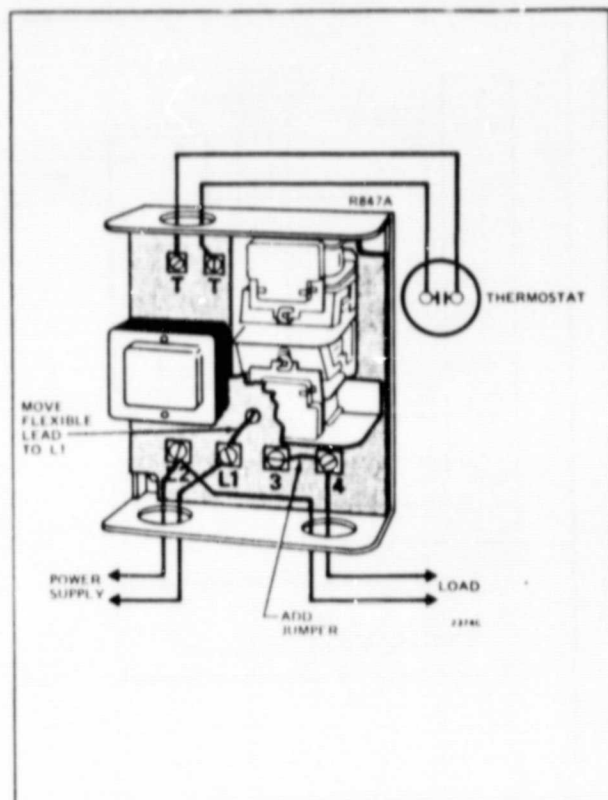


FIG. 20—R847A WIRED TO BREAK ONE SIDE OF THE CIRCUIT WITH SPST SWITCHING.

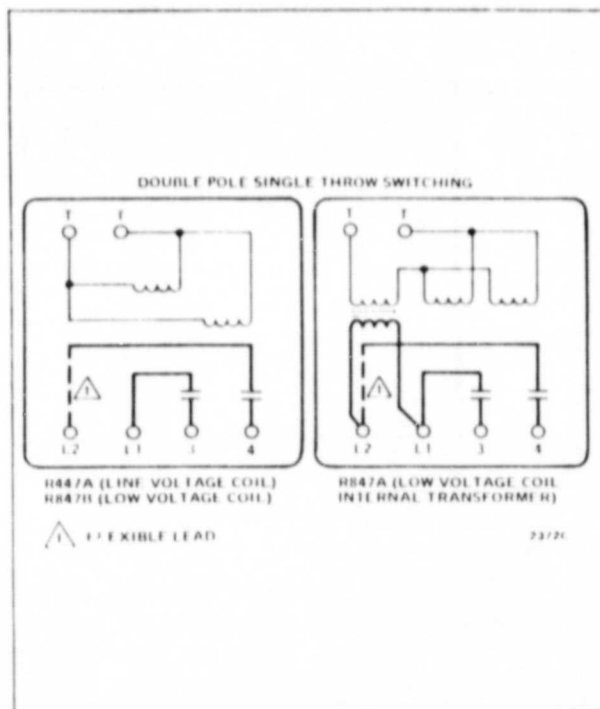


FIG. 19—INTERNAL SCHEMATICS FOR R447A AND R847A,B RELAYS AS SHIPPED FROM FACTORY.

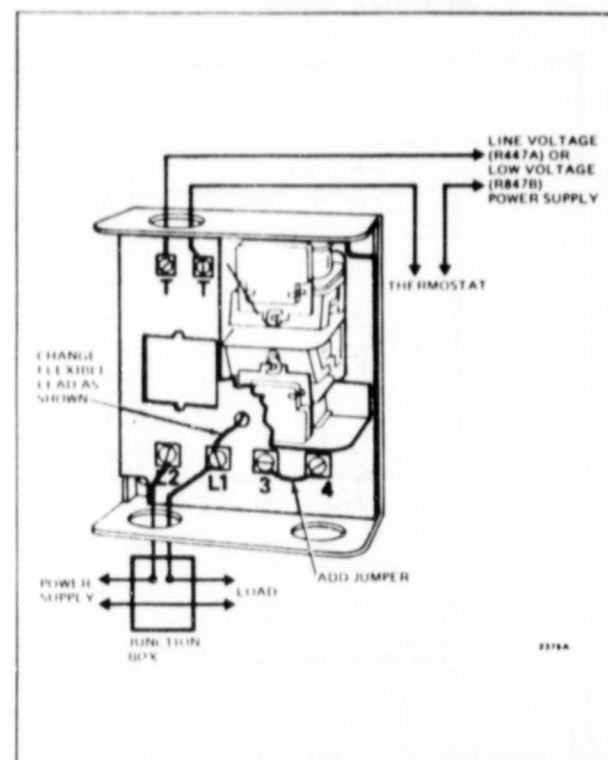


FIG. 21—R447A OR R847B WIRED TO BREAK ONE SIDE OF THE CIRCUIT WITH SPST SWITCHING.

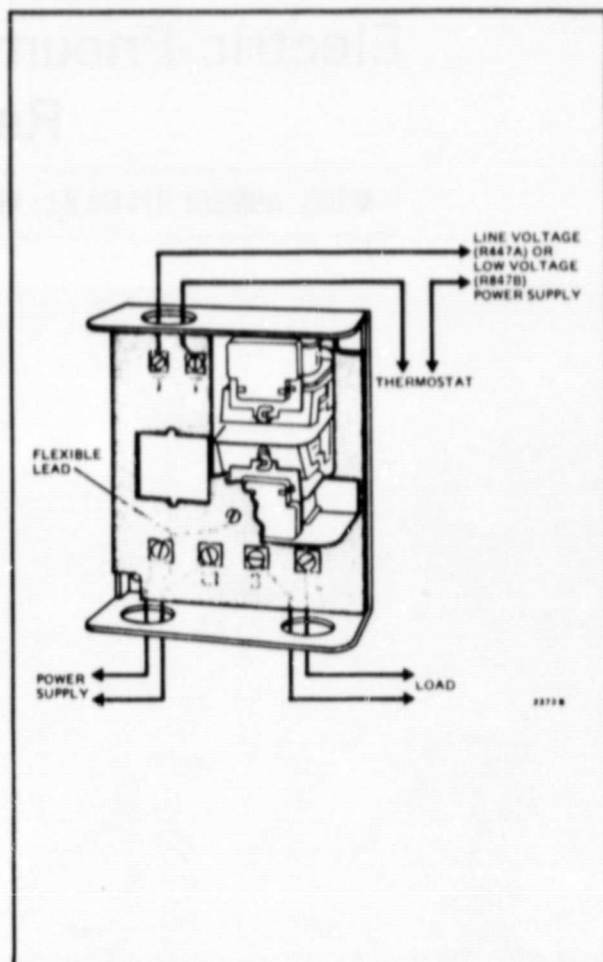


FIG. 22—R447A OR R847B RELAY WIRED TO BREAK BOTH SIDES OF THE CIRCUIT WITH DPST SWITCHING.

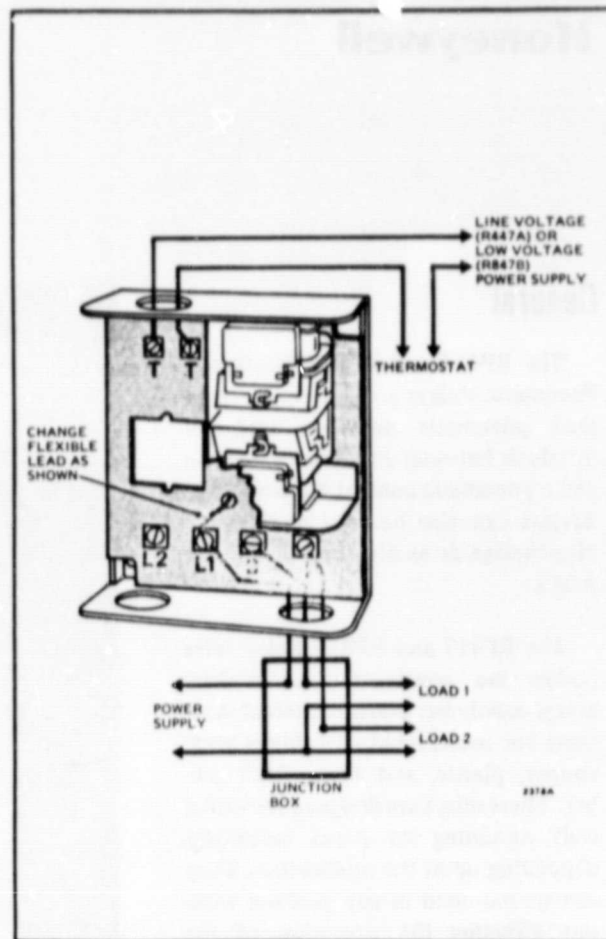


FIG. 23—R447A OR R847B WIRED TO BREAK ONE SIDE OF THE CIRCUIT WITH DPST SWITCHING TO CONTROL MULTIPLE LOADS.

SERVICE AND CHECKOUT

1. Never use oil on any part of the relay coil or contacts.

2. The cover should be kept on the relay during normal operation and removed only for service and checkout.

3. Relay contacts are arranged so that they close with a wiping action and are self-cleaning. The contacts

may turn black after being in service for some time. This discoloration does not prevent proper operation.

4. After installation is complete, operate the relay and equipment through at least 1 complete cycle to make sure that the relay controls the equipment as intended.

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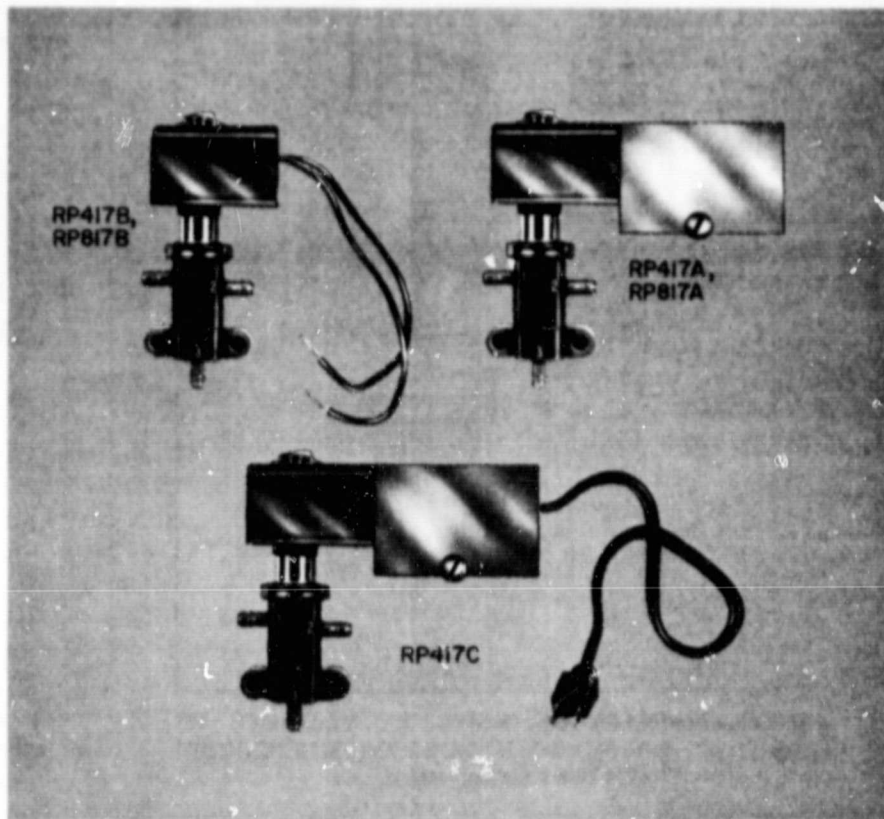
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General

The RP417 and RP817 Electronic-Pneumatic Relays are electrically operated pneumatic switches used for interlock between an electrical system and a pneumatic control system. These devices can also be used as stop and bleed relays or as diverting or selector relays.

The RP417 and RP817 Relay valve bodies are constructed of molded acetal copolymer plastic. Internal valve parts are constructed of stainless steel, copper, plastic, and Buna "N"* rubber. These relays are designed for either wall mounting or panel mounting, depending upon the application. They can be mounted in any position without affecting the operation of the device. An optional mounting kit (14003638-001) is available to facilitate direct mounting to MP516A Operators, VP519C Valves, or PP901B and PP902B Pressure Regulators.



Features

- Air connections made via 1/4 inch (6 mm) sharp barb type connectors for 1/4 inch OD polyethylene tubing.
- Can be wall or panel mounted in any position without affecting the operation of the relay.
- Constructed of acetal copolymer plastic and corrosion resistant metal.
- Available with either leadwires, junction box, or plug-in electrical connections.
- Can be directly mounted to MP-516A Operators, VP519C Valves, or PP901B and PP902 Pressure Regulators using 14003637-001 mounting adaptor (contained in 14003638-001 Kit).

Specifications

MODELS

	Line Voltage	Low Voltage	Wall Mount	Panel Mount	Device Mount	Splice Box	Open Coil	Cord & Plug
RP417A	X		X			X		
RP417B	X			X			X	
RP417C	X		X		X	X		X
RP817A		X	X			X		
RP817B		X		X			X	

AIR CAPACITY

At 20 psi (138 kPa) supply; 1 psi (7 kPa)
pressure drop: 0.30 SCFM

PRESSURE RATING

50 psi max. (3.4 bars) air

AIR CONNECTIONS

1/4 inch (6 mm), for 1/4-inch OD poly-
ethylene tubing

ELECTRICAL CONNECTIONS

Six-inch (152 mm) leads, junction box,
or cord and plug (18 gauge thermo-
plastic wire rated at 60 C)

POWER CONSUMPTION

5.7 watts maximum

AMBIENT TEMPERATURE RATING

100 F (38 C) maximum

MATERIAL

Acetal copolymer plastic and corrosion
resistant metal

DIMENSIONS

See Figures 1 and 2

WHEN SPECIFYING, INDICATE

Complete model number
Accessories

APPROVAL BODIES

RP417A, RP817A: UL Listed, Guide
Y10Z, File 9608
RP417B, RP817B, RP417C: UL recog-
nized component, Guide Y10Z2, File
9608

AVAILABLE VOLTAGE-CYCLE

Model	Complete O.S. No.	Voltage-Cycle
RP417A	1009	110/120v ac, 50/60 Hz
	1017	120v ac, 50 Hz
	1025	220/240v ac, 50/60 Hz
	1033	240v ac, 50 Hz
	1041	208v ac, 60 Hz
	1058	208v ac, 50 Hz
	1066	277v ac, 60 Hz
	1074	277v ac, 50 Hz
	1082	440/480v ac, 50/60 Hz
	1090	480v ac, 50 Hz
	1108	100v ac, 50 Hz
RP417B	1116	200v ac, 50 Hz
	1007	110/120v ac, 50/60 Hz
	1015	120v ac, 50 Hz
	1023	220/240v ac, 50/60 Hz
	1031	240v ac, 50 Hz
	1049	208v ac, 60 Hz
	1056	208v ac, 50 Hz
	1064	440/480v ac, 50/60 Hz
RP417C	1072	480v ac, 50 Hz
	1005	110/120v ac, 50/60 Hz
RP817A	1013	120v ac, 50 Hz
	1005	24v ac, 50 Hz
RP817B	1013	24v ac, 60 Hz
	1003	24v ac, 50 Hz
	1011	24v ac, 60 Hz

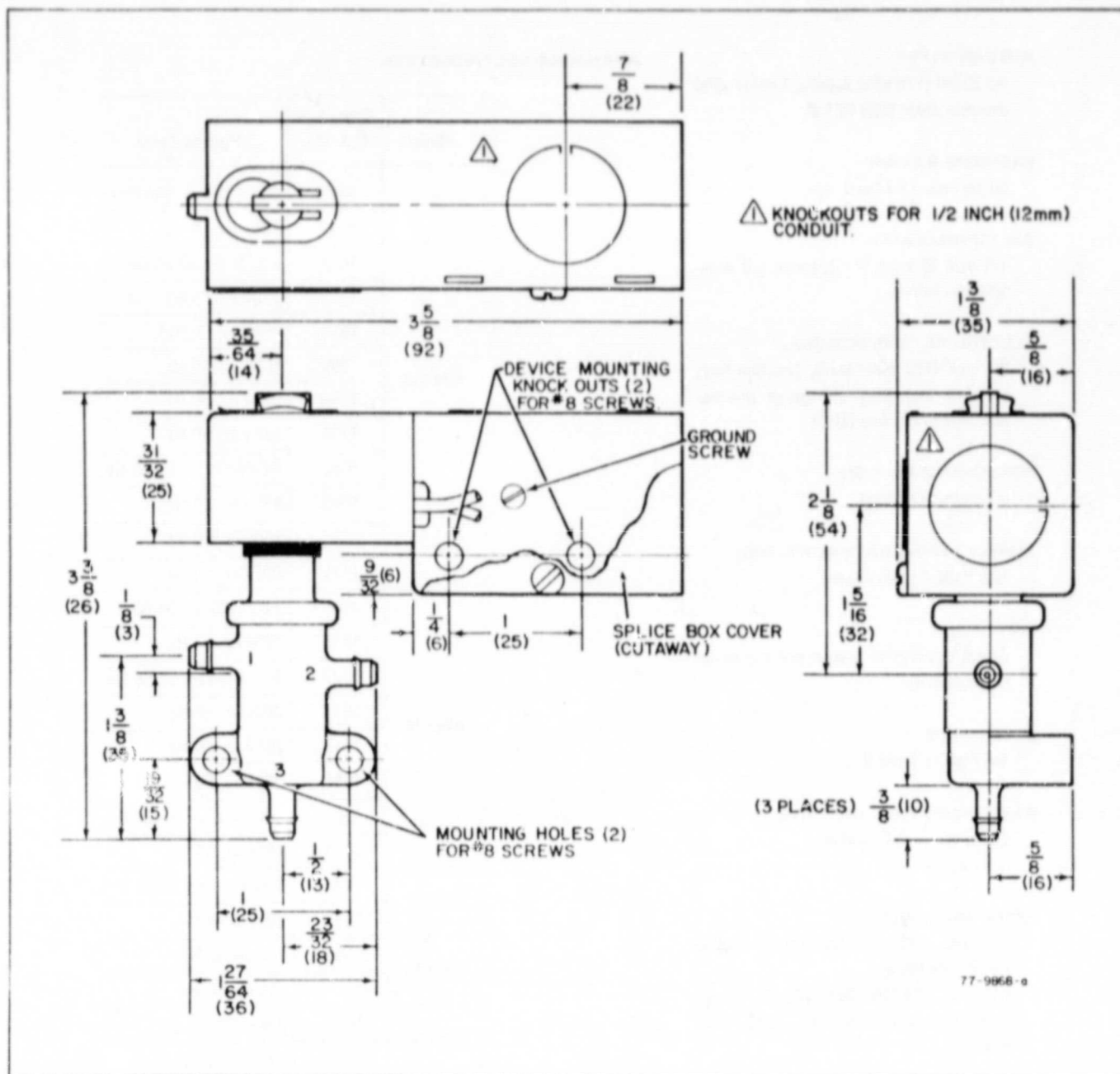


FIG. 1. DIMENSIONS IN INCHES (MILLIMETERS) OF THE RP417A, RP417C, AND RP817A

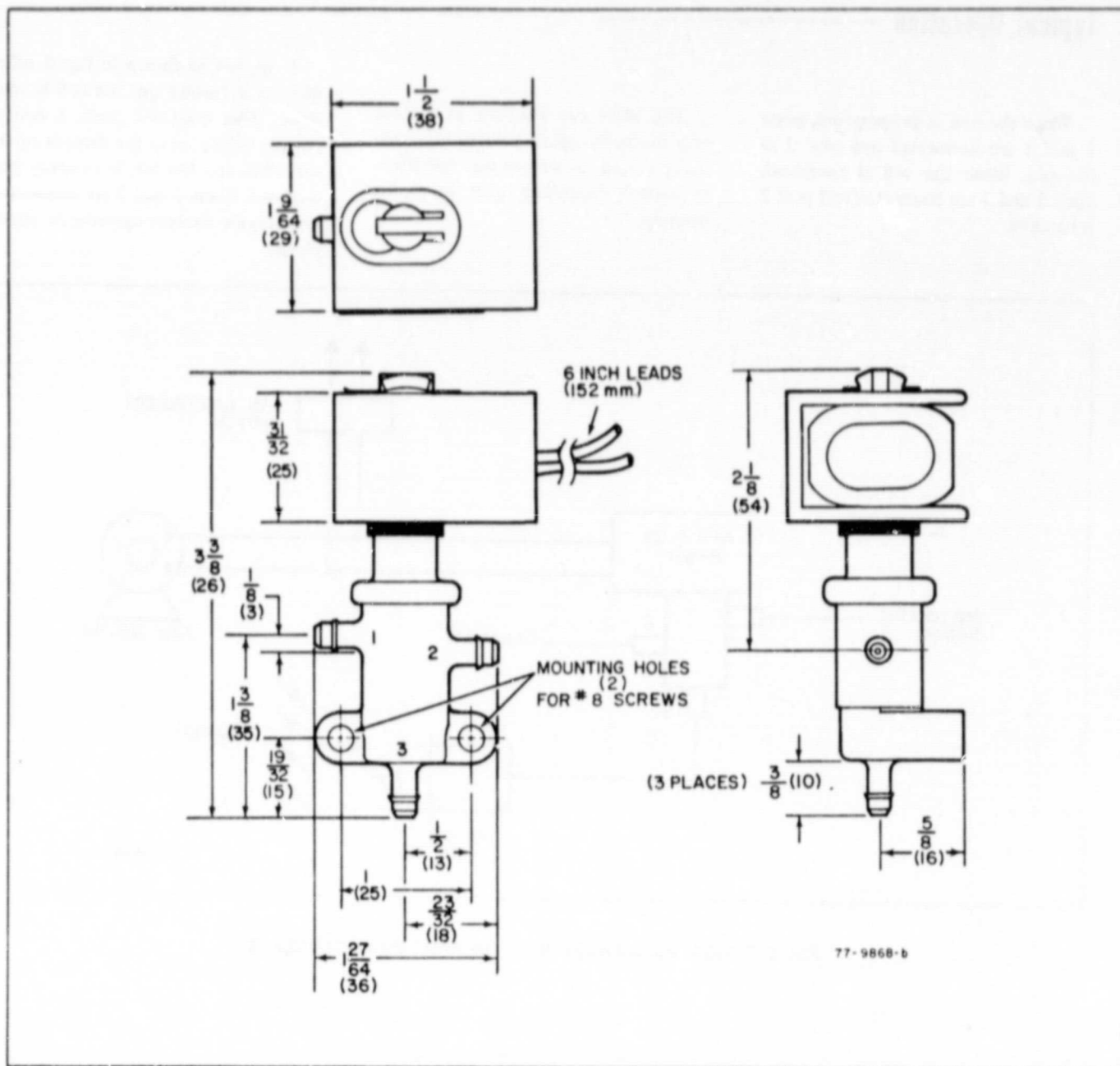


FIG. 2. DIMENSIONS IN INCHES (MILLIMETERS) OF THE RP417B AND RP817B

Typical Operation

When the coil is de-energized, ports 2 and 3 are connected and port 1 is blocked. When the coil is energized, ports 1 and 3 are connected and port 2 is blocked.

The valve can function as a three way normally open, a three way normally closed, or a three way directional control, depending upon the piping hookup.

If applied as shown in Fig. 3, when the fan is turned on, the coil is energized. This connects ports 1 and 3, passing supply air to the damper operator. With the fan off, the supply port is closed. Ports 2 and 3 are connected, bleeding the damper operator to atmosphere.

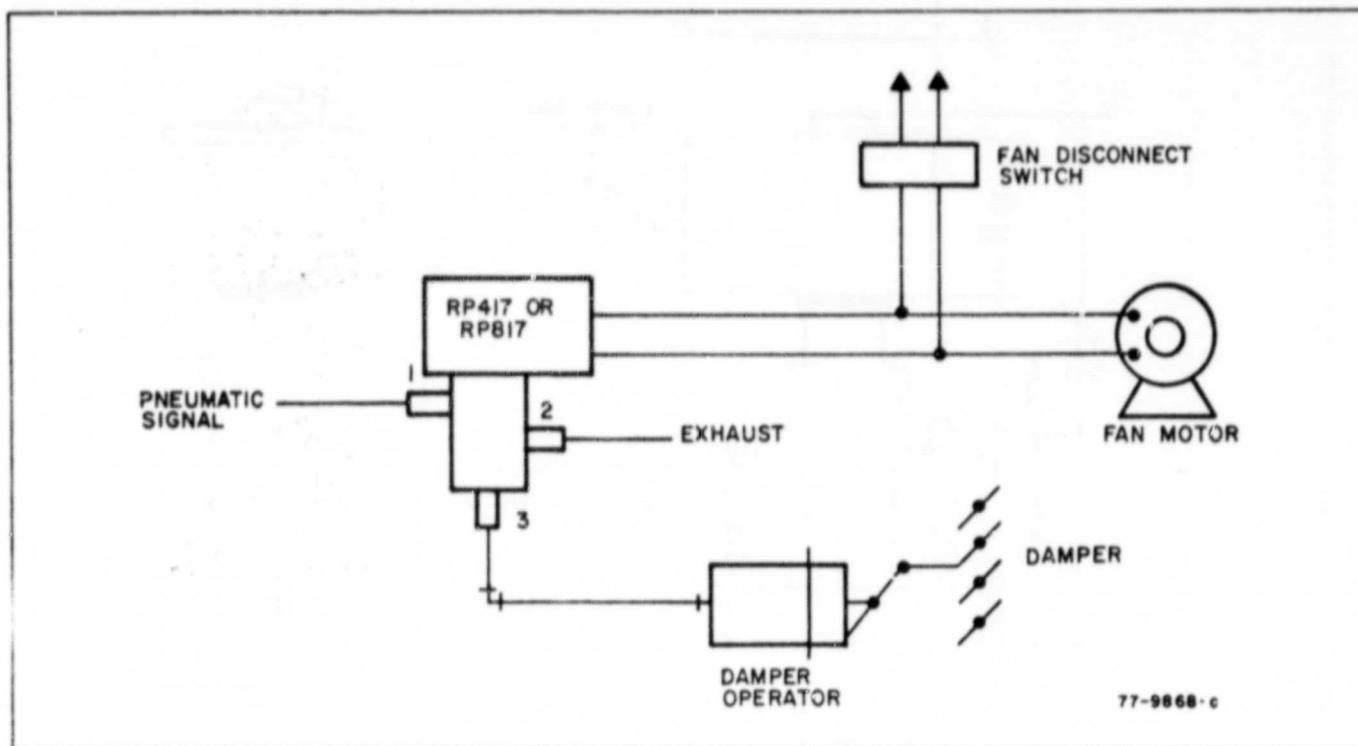


FIG. 3. TYPICAL PIPING HOOKUP OF THE RP417 OR RP817 RELAYS

General

The RP670A & B Switching Relays are two-position pneumatic relays with either single-pole (RP670A) or double-pole (RP670B), double-throw switching action. They are designed for use in pneumatic heating and cooling control systems where a valve or damper operator must be switched from one circuit to another. Switch-over pilot pressure must be two-position, not modulated.

Features

- Available with either single-pole, double-throw (SPDT) or double-pole, double-throw (DPDT) switching action.
- Second switch on DPDT (RP670B) models molded in black for identification.
- Air connections for 5/32 in. (4 mm) OD plastic tubing.
- Molded plastic construction with neoprene diaphragms, stainless steel lever, and music wire spring.
- Designed for in-line mounting but can be wall or panel mounted with a 1-1/2 in. (38 mm) diameter metal spring clip.

Specifications

MODELS

RP670A: SPDT Switching Relay; available with switch action occurring between 4 and 6 psi, 14 and 16 psi, or 19 and 21 psi (30 and 40 kPa, 95 and 110 kPa, or 130 and 145 kPa) non-adjustable.

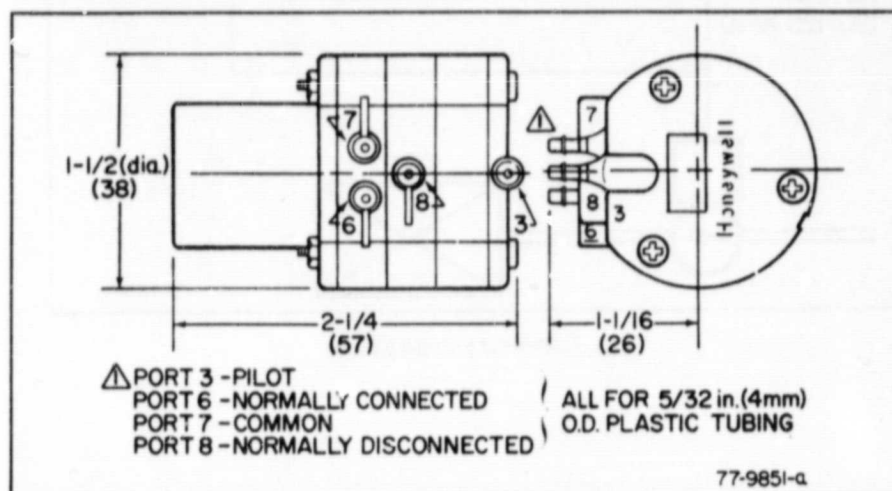
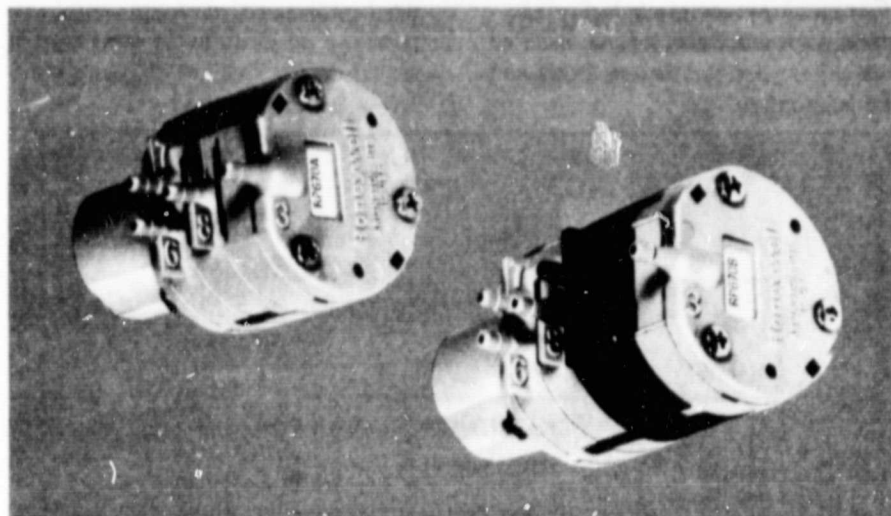


FIG. 1—APPROXIMATE DIMENSIONS OF RP670A IN INCHES (MILLIMETERS)

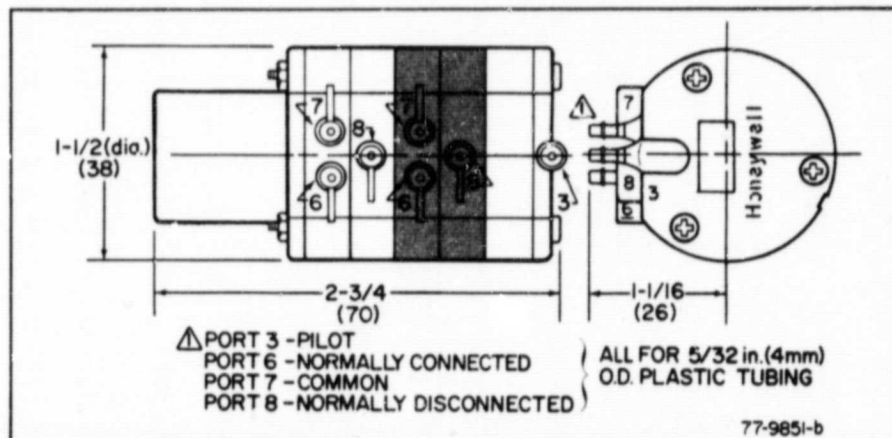


FIG. 2—APPROXIMATE DIMENSIONS OF RP670B IN INCHES (MILLIMETERS)

RP670B: DPDT Switching Relay; available with switching action occurring between 4 and 6 psi or 14 and 16 psi (30 and 40 kPa or 95 and 110 kPa), non-adjustable.

NOTE: Below minimum pressure, Ports 6 and 7 are connected and Port 8 is isolated. Above maximum pressure, Ports 7 and 8 are connected with Port 6 isolated.

OPERATING AIR PRESSURES

Pilot Pressure: 0 to 21 psi (0 to 145 kPa).

Switch Pressure: 0 to 21 psi (0 to 145 kPa).

MAXIMUM SAFE PRESSURE

30 psi (205 kPa).

AMBIENT OPERATING LIMITS

Temperature: 32 to 125F (0 to 52C)

Humidity: 5 to 95%

DIMENSIONS

Refer to Figs. 1 and 2.

WHEN ORDERING, SPECIFY

Model Number.

Mounting Clip (for wall mounting if desired) - Part No. 14003030-001.

Typical Operation (Fig. 3)

When used in a summer-winter system, during the summer cycle pilot pressure (Port 3) is below minimum switching pressure of the RP670 and Port 6 (Normally Connected) and Port 7 (Common) are connected. Port 8 (Normally Disconnected) is isolated, thereby removing the low limit controller from the system.

During the winter cycle pilot pressure is above the switching pressure, Ports 7 and 8 are connected and the low limit controller resumes its override operation to bring on heating. Port 6 is isolated.

The second switch on the RP670B (molded in black plastic for identification) can be piped to the same kind of system as the first switch, or to a different system if desired.

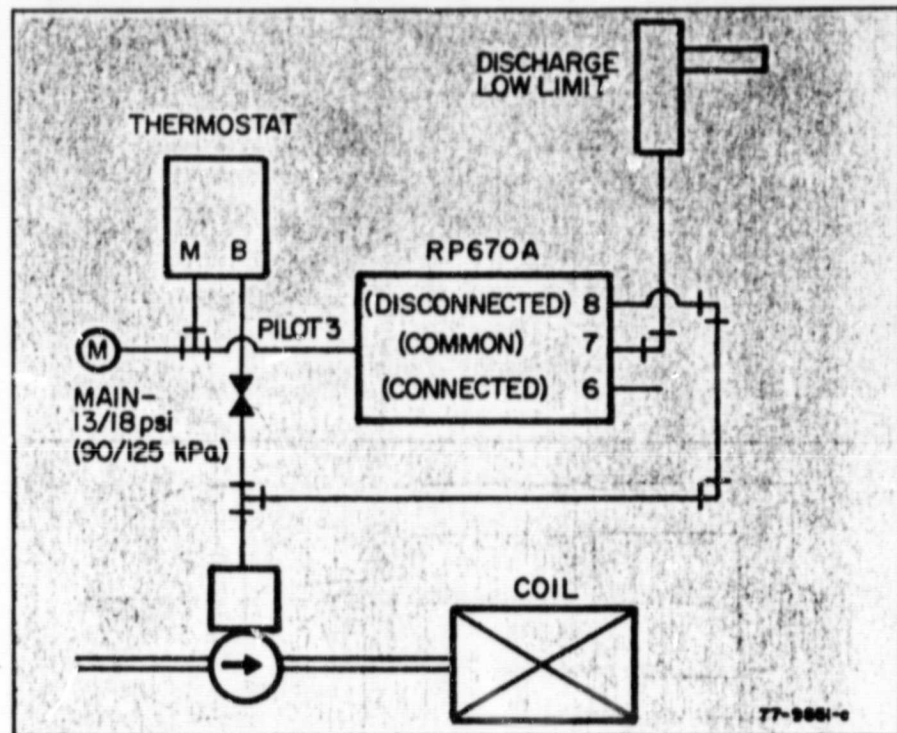


FIG. 3-TYPICAL OPERATION

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OF POOR QUALITY

RP908A & B PNEUMATIC CONTROLLERS

Service Data

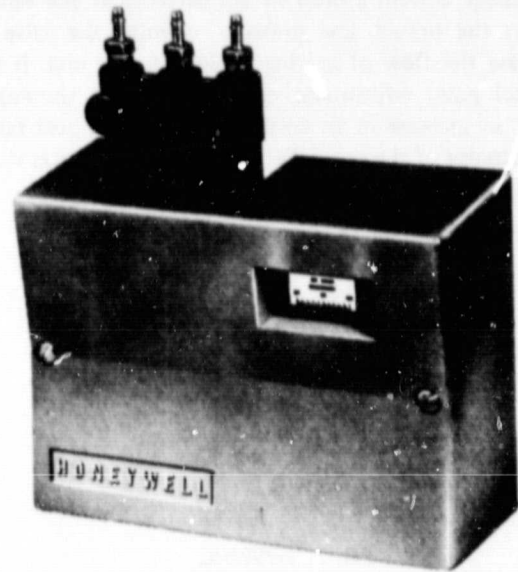
GENERAL DESCRIPTION

The RP908A and B controllers are force balance pneumatic amplifiers, with adjustable proportional bands. All models are corrosion resistant for high humidity or salt service (not in direct spray); and may be set for either direct or reverse action.

The RP908A controller, in conjunction with its remote sensor, provides proportional direct control or limit control in air conditioning systems.

The RP908B dual input controller has an adjustable authority setting for the compensating sensor relative to the system effect on the primary sensor. It is applied to compensating systems by using an additional compensating signal to change the control point of the controller. Temperature, humidity, pressure or dewpoint may be controlled by using the appropriate sensors.

Both A and B controllers have an optional model that features remote control point adjustment (CPA). This



77-9283-i

feature changes the control point from a remote location by varying the pressure on the CPA port.

Table 1.

Model	Single Input	Single Input Limit	Dual Input	With Cover	Without Cover	With CPA	Without CPA	With Calibration Knob	Without Calibration Knob
RP908A 1005	X			X			X	X	
RP908A 1013	X			X		X		X	
RP908A 1021	X				X		X		X
RP908A 1039	X				X	X		X	
RP908A 1047		X		X			X	X	
RP908A 1054	X			X			X	X	
RP908A 1062		X			X		X		X
RP908B 1003			X	X			X	X	
RP908B 1011			X	X		X		X	
RP908B 1029			X		X		X	X	
RP908B 1037			X		X	X		X	

SPECIFICATIONS

Supply Air Pressure: 18 psi (124 kPa).

Maximum Safe Air Pressure: 25 psi (172 kPa).

Ambient Temperature Limits: 40 to 120 F (4 to 90 C).

TYPICAL OPERATION

RP908A (See Fig. 1)

When used in a heating system with the controller set for direct action, a drop in temperature at the sensor lowers the branch line pressure, opening the valve to increase the flow of heating medium to the coil. If the control point adjustment model (CPA—not shown) is used, an increase in air pressure on the CPA port raises the setpoint of the controller and a decrease lowers it.

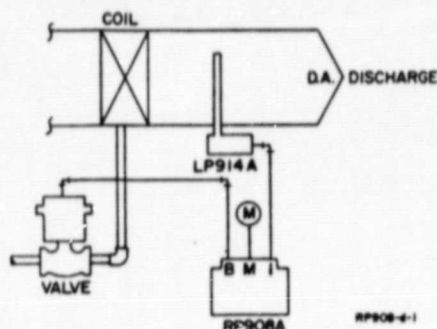


Fig. 1. RP908A.

RP908B (See Fig. 2)

An increase in outdoor temperature causes the compensating (outdoor) sensor to raise the branch line pressure. If changes occur at both the outdoor and discharge sensors, the resulting change in branch line pressure is dependent on the authority setting on the controller.

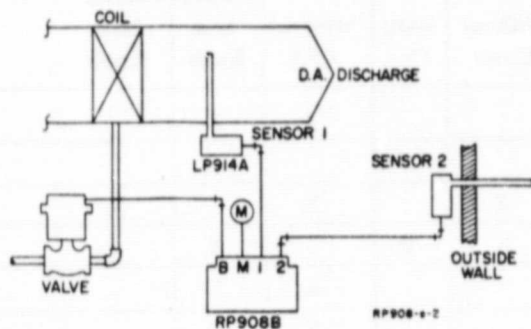


Fig. 2. RP908B.

RP908A LIMIT CONTROLLER (See Fig. 3)

When used as an economizer controller in a mixed air system, the primary controller and the mixed air sensor

act to modulate outside and return air dampers to maintain a constant mixed air temperature. When the mixed air temperature exceeds the setpoint of the primary controller, the outdoor damper opens farther and the return air damper drives toward its closed position. As the outdoor air reaches the setpoint of the primary controller, 100 percent outdoor air is taken in.

As the outdoor air temperature continues to rise and reaches the limit controller setting, its branch line pressure reduces, closing the outdoor dampers while opening the return air dampers. The dampers remain in this position as long as the outside air temperature exceeds the limit controller setpoint.

On all limit control applications, a model with a factory blocked restriction or a field modification to block the internal restriction is necessary. When a restriction is blocked, the port number is shown in a box on the drawing and a separate restricted source of air must be furnished to the sensor. When more than one controller is connected to a single sensor, the same technique of blocking the internal restriction and supplying air to the sensor(s) through a separate external restricted main is used. If there is variable pressure on the "M" port, the separate main assures proper calibration of the limit control and accurate indication of its sensor temperature.

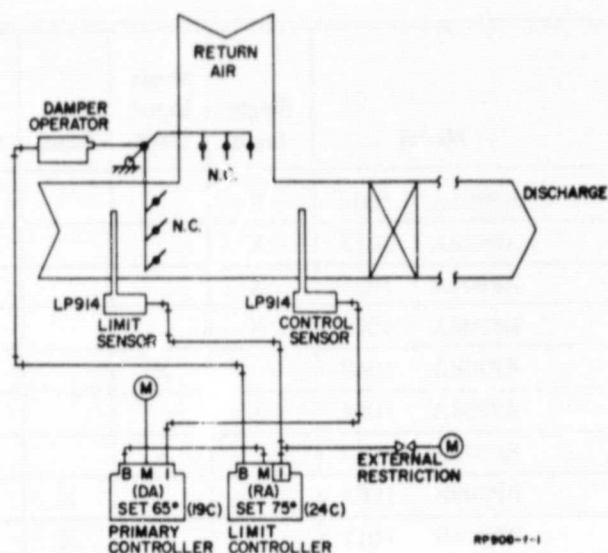


Fig. 3. RP908A Limit Controller.

RP908A LOW LIMIT CONTROLLER (See Fig. 4)

Used as a low limit controller, the RP908A reduces branch line pressure to open a heating valve to main-

tain the discharge temperature at its setpoint when the primary controller is partially or completely satisfied.

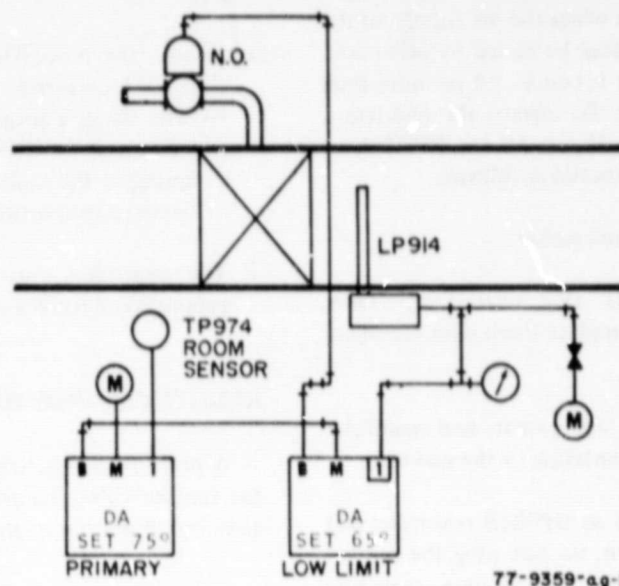


Fig. 4. Low Limit Controller.

MAINTENANCE

The only preventive maintenance necessary is an annual visual check for leaks, loose fittings, etc and an operational and calibration check.

Use PLASTILUBE* (311057, 2 oz. tube) for "O" rings, screw threads, etc. Use MOLYCOTE* or similar commercial powdered lubricant for pivots and plungers in units with CPA.

OPERATIONAL CHECK

Vary the pressure slowly in ports 1 and 2. The main lever should move smoothly, and the branch line pressure should change gradually in the proper direction.

CALIBRATION CHECK

RP908A—Change the setpoint of the controller to the existing sensor temperature if the two don't already match. The branch line pressure should be at its calibration pressure (8 ± 1 psi [55 ± 7 kPa]) unless otherwise noted. If recalibration is necessary, see Calibration Procedure.

RP908B—Determine the existing calibration temperature from the reset schedule. Measure the temperature at the port 1 sensor. These temperatures should agree within 2 percent of the sensor range span and the branch line pressure should be within the operating range of the controlled device. See Calibration Procedure for RP908B if recalibration is necessary.

FIELD MODIFICATIONS

CHANGE FROM DIRECT ACTING TO REVERSE ACTING

The change from direct to reverse is made by following the three steps listed in Figure 5.

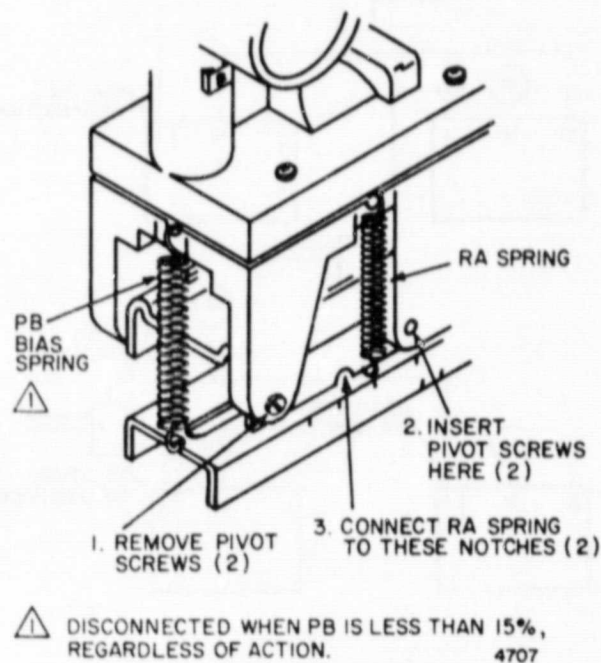


Fig. 5. Set-Up for Reverse-Acting Operation.

REPLACEMENT OF RESTRICTION WITH BLANK PLATE

The internal restriction must be replaced with a blank plate when the sensor is supplied with an external source of restricted air. This occurs when the air supply to the "M" port of the controller may be varied by other controls or when a single sensor is connected to more than one controller (see Fig. 6). To replace the restriction with a blank plate, refer to Figure 10 for RP908A or Figure 12 for RP908B and proceed as follows.

1. Remove the manifold and gasket.
2. Remove the port 1 "O" ring, restriction, screen, filter, and washer and replace them with the blank plate No. 316125.
3. Reassemble the "O" ring, gasket, and manifold, carefully noting the orientation of the gasket.

When using only one port of an RP908B controller and the restriction is not blocked, do not plug the unused port but leave it open to avoid building up to main line pressure in the sensor chamber. Two models of the RP908A are provided with a factory installed blank. These models are identified by a red manifold. When field installing a blank, the manifold should be marked indicating that the restriction is blocked.

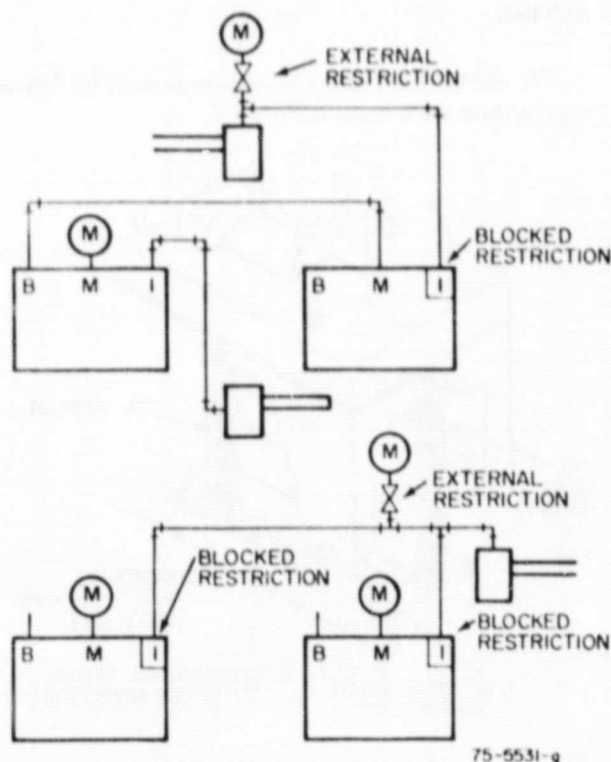


Fig. 6. Blank Plate Used to Block Restrictions.

ADJUSTMENTS

PROPORTIONAL BAND ADJUSTMENTS (Refer to Fig. 7)

1. Loosen the proportional band adjustment knob and slide the indicator to the desired proportional band.
NOTE: When a proportional band of more than 15 percent is used, fasten the proportional band bias spring to the main lever. (This spring is left unconnected if proportional band is 15 percent or under.)
2. The controller must be recalibrated whenever the proportional band is changed.

REMOTE CONTROL POINT ADJUSTMENT

A pressure change from 3 to 13 psi (20 to 90 kPa) in the remote CPA, changes the control point proportionately by 20 percent of the sensor span.

SETPPOINT ADJUSTMENT (See Fig. 8)

The setpoint is raised by turning the setpoint adjustment screw counterclockwise. This increases the force from the setpoint spring on the main lever so that a greater force from the sensor chamber is required to cause an increase in branch line pressure.

The setpoint adjustment screw has a vernier for fine adjustment. The screw has 10 marked divisions; each division equals 1/2 percent of the sensor span (1 F per division for a 200 degree sensor span, or 20 turns for the whole span).

CALIBRATION

Always calibrate with 18 psi (124 kPa) main air pressure. On CPA models, set CPA to 8 psi (55 kPa). A 0 to 30 psi (0 to 207 kPa) gage must be installed in branch port line during calibration and a temperature, humidity or pressure gage should be installed in port 1 (and port 2, if RP908B is used). If the reset signal on an RP908A is produced by the output of a room thermostat or pressure control, a 30 psi (207 kPa) gage must be installed in the No. 2 port. Otherwise, the scale range on the gage should match the range of the sensor for ports 1 and 2.

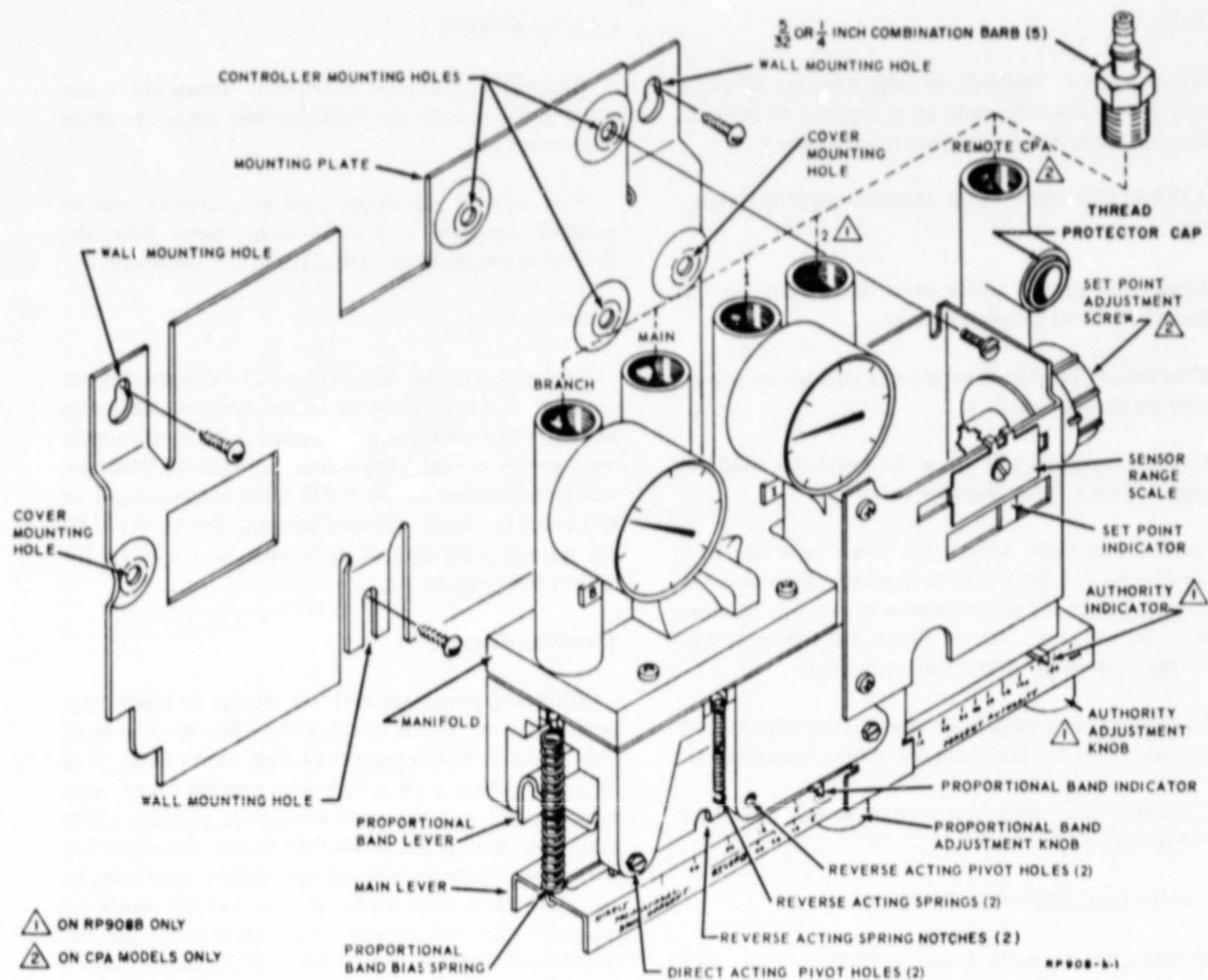


Fig. 7. RP908 Controller.



Fig. 8. RP908A & B Setpoint Adjustment.

RP908A

There are two methods of calibrating the RP908A when 18 psi (124 kPa) main air is supplied to the controller and the internal restriction is not blocked.

CALIBRATION USING THE ADJUSTABLE RESTRICTION

1. Install the proper sensor range scale plate on the controller if not installed already.
2. Disconnect the port 1 sensor and connect an adjustable restriction to port 1.
3. Choose a setpoint and adjust the restriction until the gage in port 1 shows this setpoint.
4. Turn the setpoint adjustment screw until the BLP reads 8 psi (55 kPa). This is standard calibration. On some applications the calibration branch line pressure may be set at a different point that relates to the spring range of the device being operated.
5. Move the sensor range scale plate to the setpoint and tighten the scale. The controller is now in calibration.
6. Disconnect the adjustable restriction and reconnect the sensor.

CALIBRATING WITH GAGES ONLY

1. Install gages in ports 1 and B (Port 1—gage must match sensor, port B—30 psi [207 kPa] gage is used).
2. Install the proper sensor range scale plate on the controller if not already done.
3. Turn the setpoint adjustment screw until BLP is 8 psi (55 kPa) or other selected calibration pressure. (See step 4 above.)
4. Move the scale until the setpoint indicator is at the reading shown on the port 1 gage and tighten the scale.
5. Adjust the setpoint to the desired control setting.

RP908B

The only method of calibrating the RP908B dual input controller is to use an adjustable restriction. If the settings are known, proceed to step No. 1 of the procedure. If they must be calculated, read the following information and calculate as shown. The authority calculator (Part No. 813) may be used to simplify these calculations.

CALCULATIONS

Although this typical example is shown for a hot water reset system, the formulae also apply to other reset systems.

Four separate parameters must be known in order to properly calibrate a reset system: Reset Schedule, Throttling Range, Proportional Band, and Authority.

Reset Schedule

The reset schedule will be plotted by determining the outdoor air temperature at which designed maximum heating water temperature is needed and the outdoor air temperature at which no heating is required. Minimum water temperature of 90 F (32 C) is recommended at this point for direct radiation systems. Use 80 F (27 C) for systems with heating coils, and 75 F (24 C) for radiant floor panels.

Throttling Range (TR)

Throttling range indicates the change in water temperature at the sensor to cause the valve to move from fully open to fully closed (full heat to no heat). It is desirable to have a TR as narrow as possible for efficient valve control and yet wide enough to produce stable valve operation. A TR of 10 F (5 C) is a recommended trial setting. If the system will not stabilize after being in operation for a short period of time, the TR should be increased (this will require recalculation of the proportional band and authority). An unstable system can be recognized by frequent, repetitive changes in branch line pressure, known as hunting or cycling.

When the throttling range has been selected, it must be converted to a proportional band value that can be set on the controller.

Proportional Band (PB)

Proportional Band is similar to TR except it is expressed in terms of percent of temperature change rather than degrees. Proportional band can be determined by using the following formula:

$$\frac{\text{TR}}{\text{Sensor Span}} \times 100 = \text{PB \%}$$

Example:

When a sensor having a 200 degree span is used and a 10 degree TR has been selected:

$$\frac{10}{200} \times 100 = 5\%$$

Authority

Authority indicates the amount of effect that the change in outdoor air temperature will have on the control point. Authority can be determined by the following formula:

$$\text{Authority} = \frac{\Delta T_1 + \text{TR}}{\Delta T_2} \times 100$$

Where:

TR = Throttling Range

ΔT_1 = Change in Hot Water Temperature

ΔT_2 = Change in Outdoor Air Temperature

Example:

Determine settings for a system where hot water should be controlled at 180 F when outdoor air temperature is -10 F, and reduced to 90 F when outdoor air is 65 F. Assume a TR of 10 F.

Reset Schedule

Outdoor Air Temperature (T_2) Sensor 2	Hot Water Temperature (T_1) Sensor 1
-10 F	180 F
65 F	90 F

$$\Delta T_2 = 65 - (-10 \text{ F}) = 75 \text{ F}$$

$$\Delta T_1 = 180 - 90 = 90 \text{ F}$$

$$\text{TR} = 10 \text{ F (assumed)}$$

$$\text{PB} = \frac{10}{200} \times 100 = 5\%$$

$$\text{Authority} = \frac{90 + 10}{75} \times 100 = 133\%$$

RP908B CALIBRATION PROCEDURE

1. Install the sensor range scale plate matching the port 1 sensor on the controller if not already done.
2. Disconnect the sensors to ports 1 and 2 and connect an adjustable restriction to each port. If an external main has been connected to the sensor line, install the adjustable restriction on the sensor side of the tee.
3. Select the low end of the sensor 1 schedule (90 F or 32 C). Adjust the No. 1 restriction until the sensor 1 gage reads that temperature.
4. Select the high end of the sensor 2 schedule (65 F or 18 C). Adjust the No. 2 restriction until the sensor 2 gage reads that temperature.
5. Set the Authority and Proportional band into the controller. Adjust the setpoint adjustment screw until the branch line gage reads 12 psi (89 kPa), or until it reads the "valve close" pressure if the valve has other than a standard 4 to 11 psi (27 to 76 kPa) spring range.
6. Move the sensor range scale plate until the desired setpoint lines up with the setpoint indicator and tighten the scale plate. The controller is now in calibration.

REPAIR

To replace internal filters, screens, restrictions, and "O" rings, use repair kit Part No. 14002696-001.

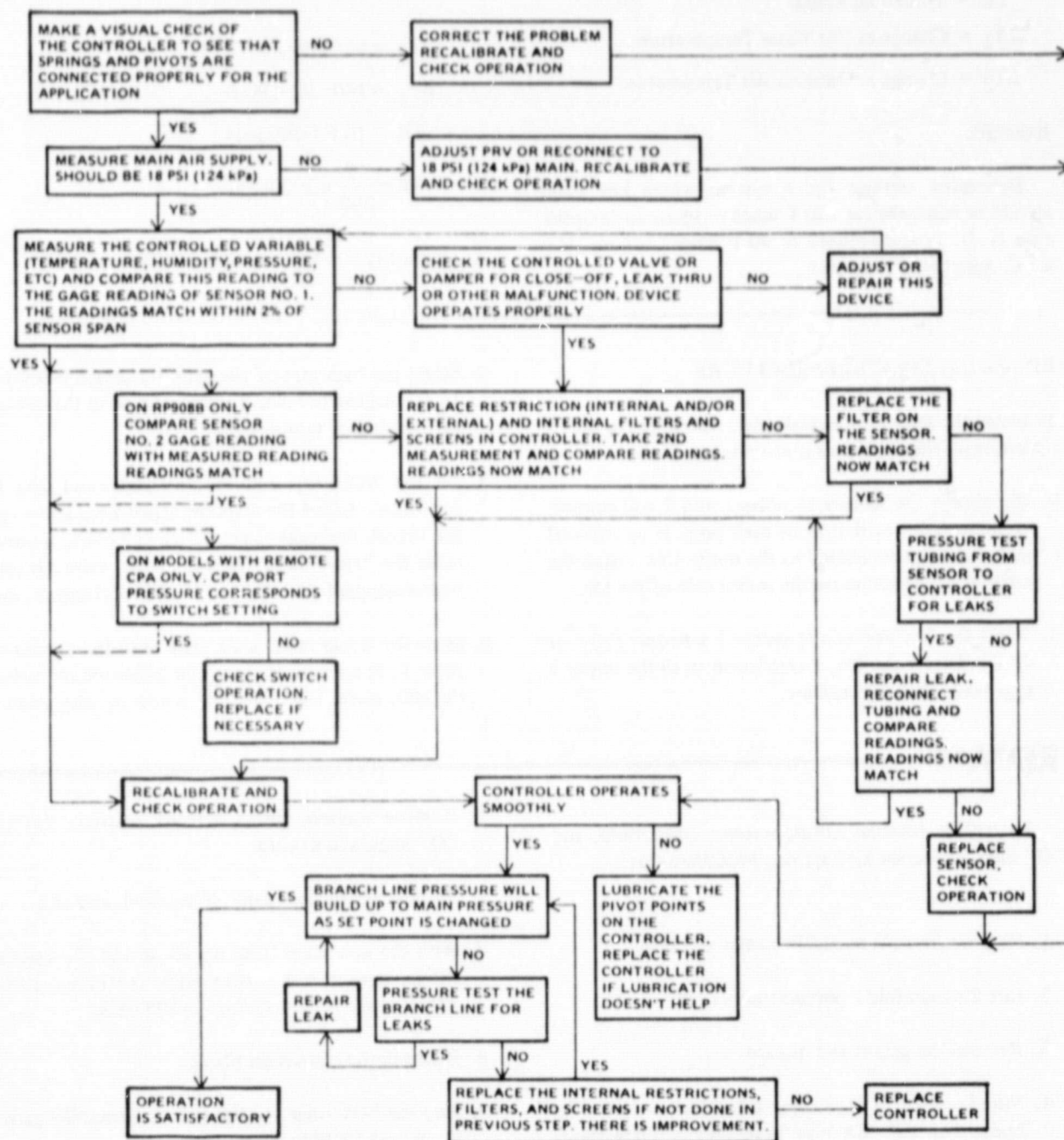
1. Remove four (4) manifold screws and save.
2. Lift the manifold from controller body.
3. Remove the gasket and discard.
4. Note location of filters and restrictions in controller body. The RP908A may have two or three filters and the RP908B may have three or four. Some controllers may have a blank plate in place of a restriction, filter, screen and washer.
5. Remove washers, filters, screens, restriction(s) and "O" rings, and discard.
6. Remove restriction blank, if installed, and save.
7. With the new parts from the kit, install the washers, filters, screens and restriction(s). See Figure 10 for RP908A and Figure 12 for the RP908B.
8. Reinstall the restriction blank.
9. Add the "O" rings and the gasket. Orient the gasket in the way that blocks no ports.
10. Place the manifold in position on the gasket and install the original four screws. Tighten securely.

TROUBLESHOOTING

See Flowchart.

NECESSARY TEST EQUIPMENT—CALIBRATED GAGE SET (No. 816A)

If the sensor-controller is not maintaining control:



75-5531-h

PARTS

SEE FIGS. 10 THRU 13 FOR
DETAILED BREAKDOWN
OF THESE PARTS

ON EARLIER MODELS OF THESE
CONTROLLERS THE SENSOR INPUT
PORTS WERE DESIGNATED T2 AND
T3. THESE HAVE BEEN CHANGED
TO 1 INSTEAD OF T2, AND 2 IN-
STEAD OF T3.

BACKPLATE

COVER

315282 ON RP908A WITHOUT CPA
315283 ON RP908ABB WITH CPA
315255 ON RP908B WITHOUT CPA

SCREW 315293 (2)

Fig. 9. Exploded View of Controller Assembly.

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75-5531

RP908A

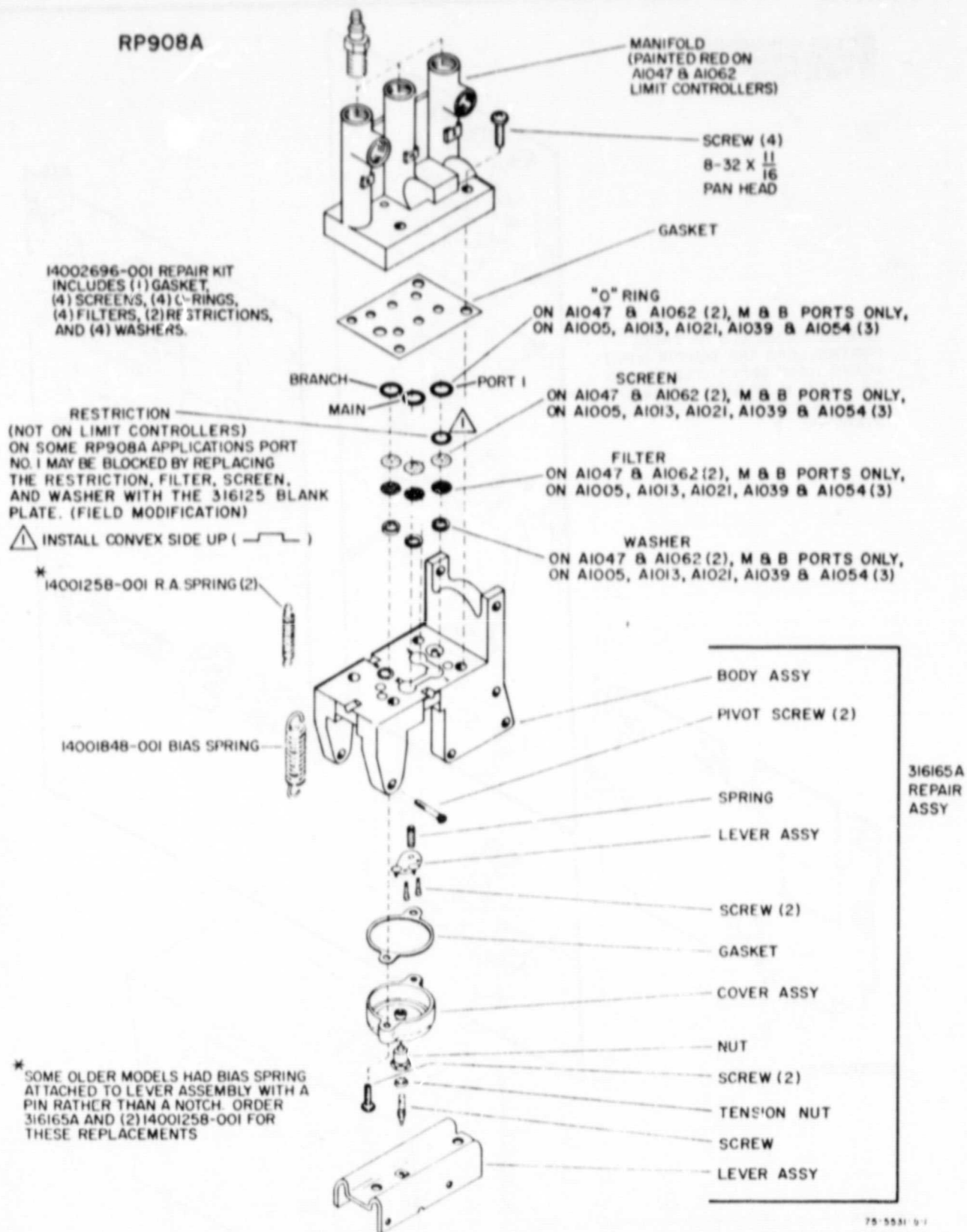


Fig. 10. Detail of RP908A Manifold and Body Assembly.

RP908A

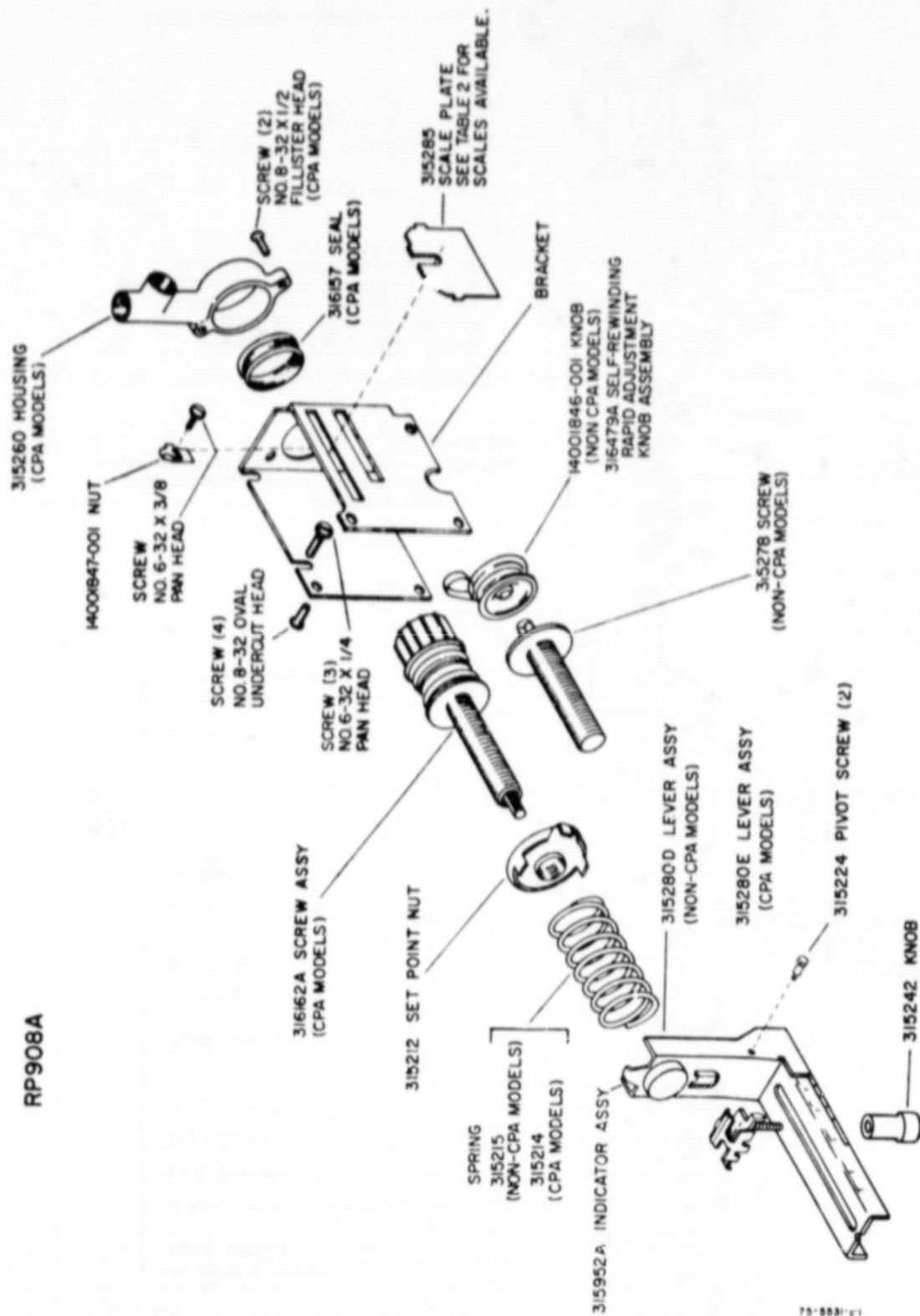


Fig. 11. Detail of RP908A Bracket and Indicator Assembly.

RP908B

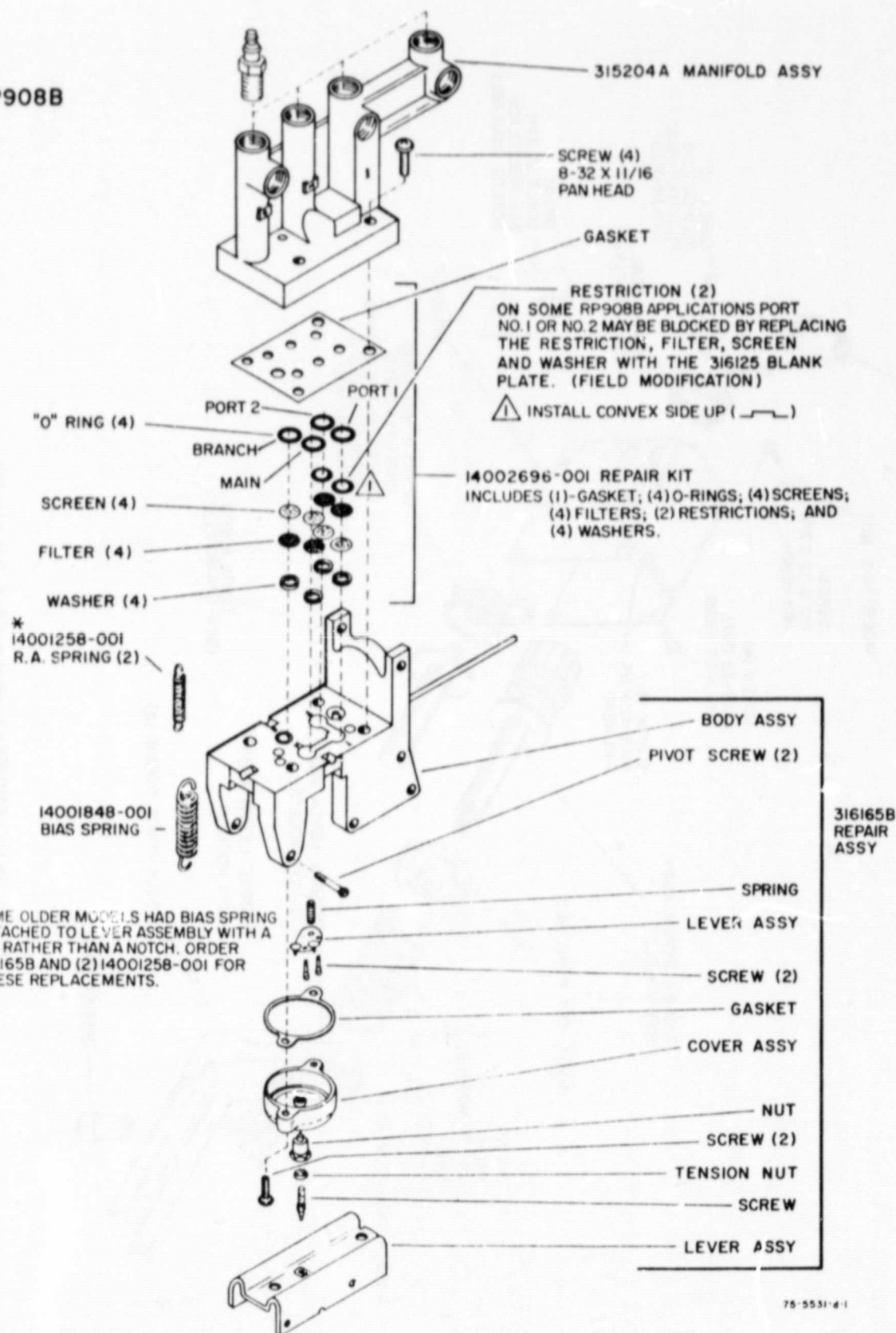


Fig. 12. Detail of RP908B Manifold and Body Assembly.

ORIGINAL PAGE IS
OF POOR QUALITY

RP908B

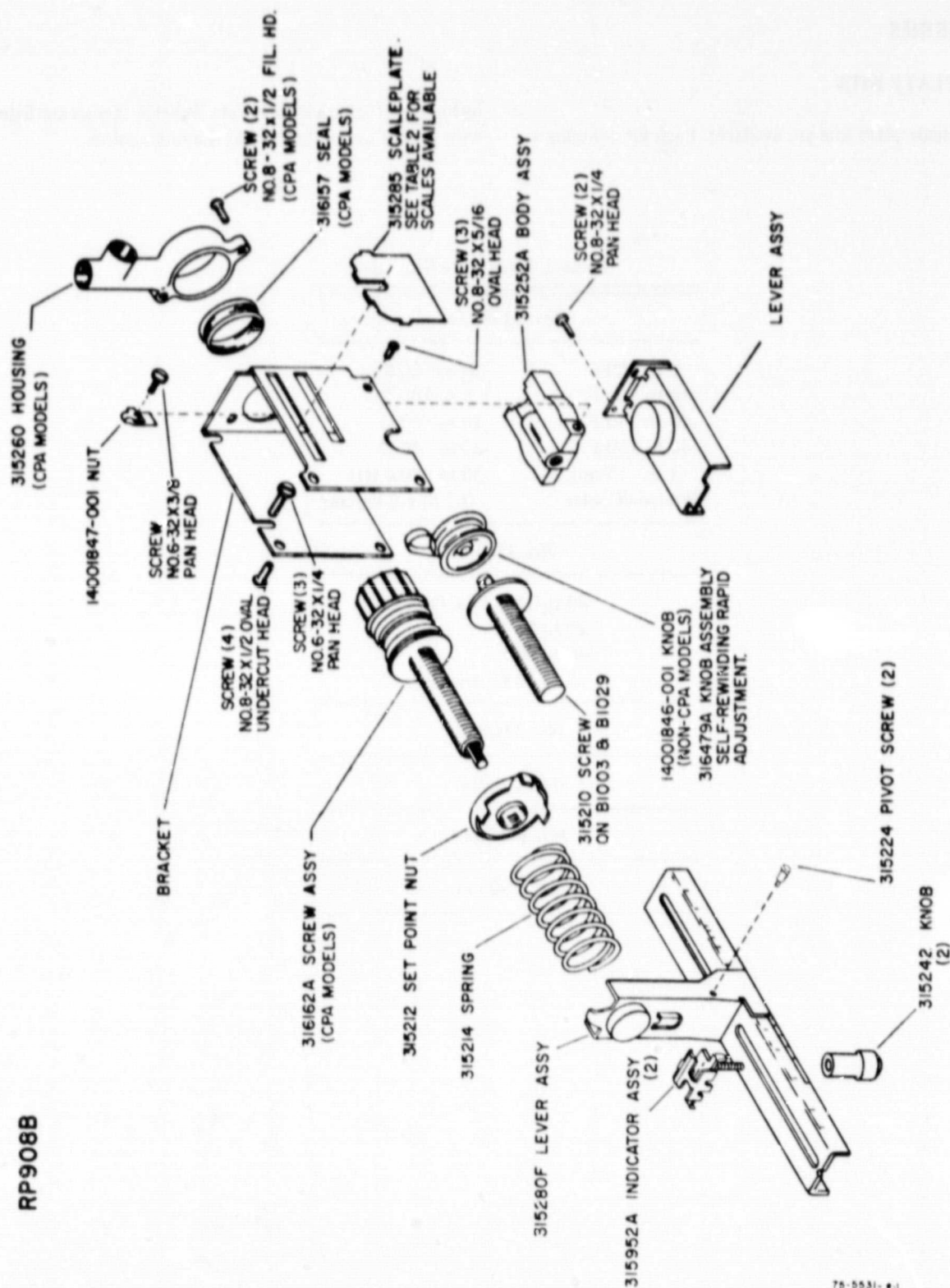


Fig. 13. Detail of RP908B Bracket and Indicator Assembly.

75-5531-4

ACCESSORIES

SCALE PLATE KITS

Four scale plate kits are available. Each kit contains a

different set of stick-on decals. Specific decals are listed with proper order numbers in the table below.

Table 2. Scale Plate Kits.

No. 315993A	
0 to 200 F	-20 to 80 C
-40 to 160 F	5 to 105 C
-40 to 240 F	10 to 40 C
50 to 150 F	-30 to 30 C
3 to 15 psig	30 to 80% RH
Warmer/Cooler	0.2 to 1.0 kg/cm ²
No. 316193	
40 to 75 F Dew Point	
-20 to 80 F	
-40 to 60 C	
-5 to 25 C Dew Point	
No. 316005A	
0 to 6 inches	
No. 316089A	
0 to 150 mm	

GAGES

The 1-1/2 inch gages are listed below. 2-1/2 and 3-1/2

inch gages are also available. They are found on Form No. 74-1269.

Table 3. Gages.

Gages (1-1/2 in. dia back conn. 1/8 NPT)	Scale Range	For Use with Sensor
14000786-001	25 to 125 F	LP914
14000786-002	-5 to 55 C	LP914
305929	-40 to 160 F	LP914
305932	-40 to 70 C	LP914
305931	40 to 240 F	LP914
305934	5 to 115 C	LP914
305986	-20 to 80 F	LP914
305987	-30 to 30 C	LP914
305930	0 to 200 F	LP915
305933	-18 to 93 C	LP915
305972	50 to 100 F	TP924, TP974 & TP925
305973	10 to 38 C	TP924, TP974 & TP925
Relative Humidity		
305974	30 to 80%	HP901 & HP902
14000786-003	15 to 75%	HP971
14000786-004	65 to 95%	HP971
Dew Point		
305988	40 to 75 F DP	TP925A1018
305989	5 to 25 C DP	TP925A1018
Pressure		
305965	0 to 30 psi	
305615	-1 to 1 in. of WC	PP905
305621	-25 to 25 mm of WC	PP905
305616	0 to 2 in. of WC	PP905
305622	0 to 50 mm of WC	PP905
305617	1 to 3 in. of WC	PP905
305623	25 to 75 mm of WC	PP905
305618	2 to 4 in. of WC	PP905
305624	50 to 100 mm of WC	PP905
305619	3 to 5 in. of WC	PP905
305625	75 to 125 mm of WC	PP905
305620	4 to 6 in. of WC	PP905
305626	100 to 150 mm of WC	PP905

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*Inc. des manufacturing facilities

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General

The RP971A Ratio Relay is a four port non-bleed pneumatic relay which produces a modulating pressure output proportional to pilot pressure changes. It is used for controlling pneumatic valve or damper motors in sequence from a single thermostat.

Features

- Adjustable pilot start point pressures.
- Two pilot pressure ranges available.
- Four (4) sharp barb air connections: Main is for 1/4 in. (6 mm) OD tubing, Branch, Pilot, and Exhaust are for 5/32 in. (4 mm) OD tubing.
- Molded plastic construction with neoprene diaphragms and stainless steel valve seats.
- 100 mesh stainless steel screens in main and branch ports.
- Designed for in-line mounting but can be wall or panel mounted with standard 2 in. (51 mm) diameter cable clamp.

Specifications

MODELS

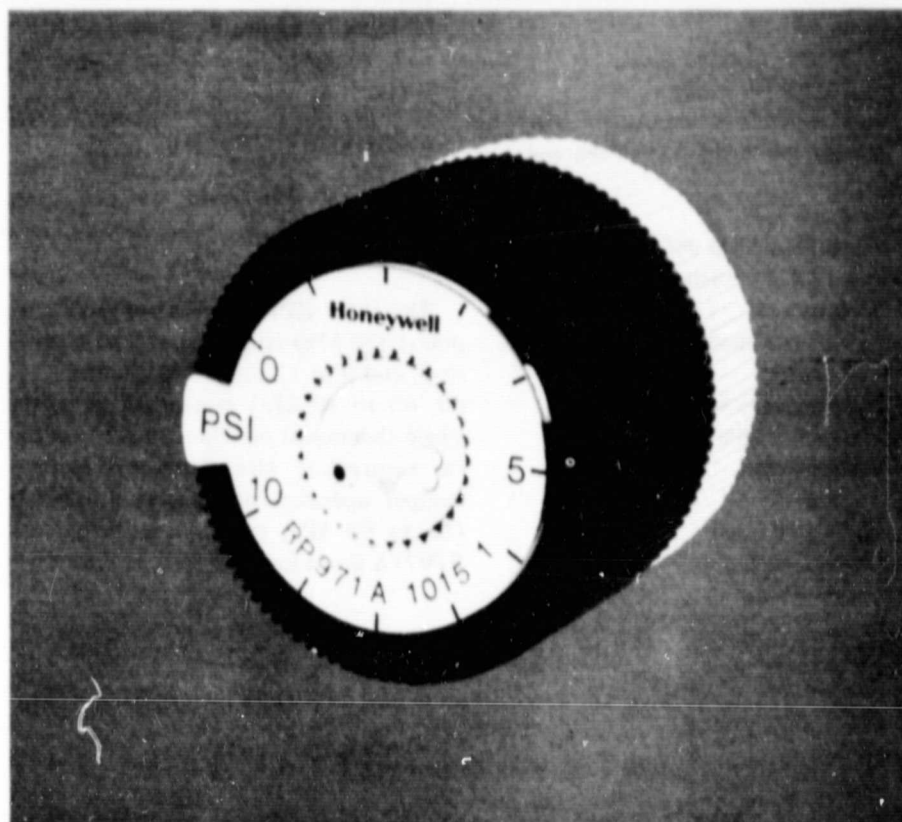
RP971A: Pilot pressure ranges of 3 or 5 psi (20 or 35 kPa), non-adjustable.

START POINT

Adjustable from 0 to 10 psi (0 to 70 kPa).

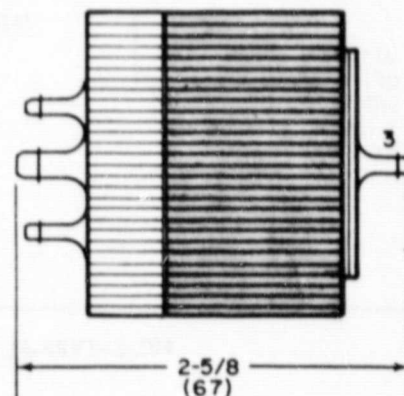
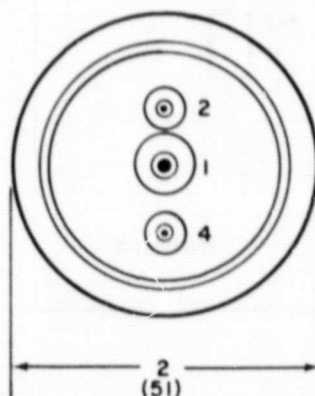
MAXIMUM SAFE AIR PRESSURE

30 psi (205 kPa)



FORT IDENTIFICATION

PORT 1 MAIN - FOR 1/4 IN (6mm) O.D. TUBING
 PORT 2 BRANCH
 PORT 3 PILOT
 PORT 4 EXHAUST } FOR 5/32 IN (4mm) O.D. TUBING



77-9849-a

FIG. 1—RP971A DIMENSIONS IN INCHES (MILLIMETERS)

NORMAL OPERATING PRESSURES

Main: 18 psi (120 kPa). Pilot: 3 to 15 psi (20 to 100 kPa).

AIR CONSUMPTION

0.0017 SCFM (50 SCCM)

AIR HANDLING CAPACITY (Feed and Bleed)

0.039 SCFM at 1 psi differential (1,100 SCCM at 6.9 kPa differential)

AMBIENT OPERATING LIMITS

Temperature: 0 to 140F (-18 to 60C)
Humidity: 5 to 95%

DIMENSIONS

Refer to Figure 1

WHEN SPECIFYING, INDICATE

Model Number

Pilot Pressure Range Desired (3 or 5 psi [20 or 35 kPa])

Cable Clamp (2 in. [51 mm] dia.) for wall mounting if desired, Part Number 801629T

Typical Operation

The three RP971A relays with a 3 pound (20 kPa) range are set 3 to 6, 6 to 9, and 9 to 12 psi (20 to 40, 40 to 60, 60 to 80 kPa) respectively. The single thermostat can then proportion, in sequence, the three identical damper operators having 3 to 13 psi (20 to 90 kPa) springs through the RP971A Ratio Relays.

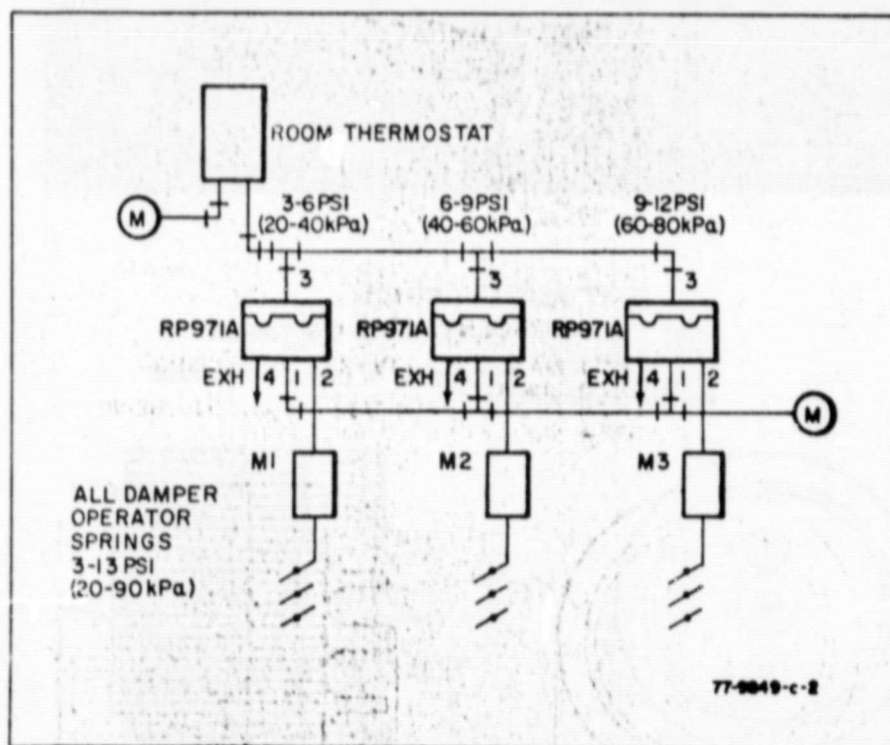
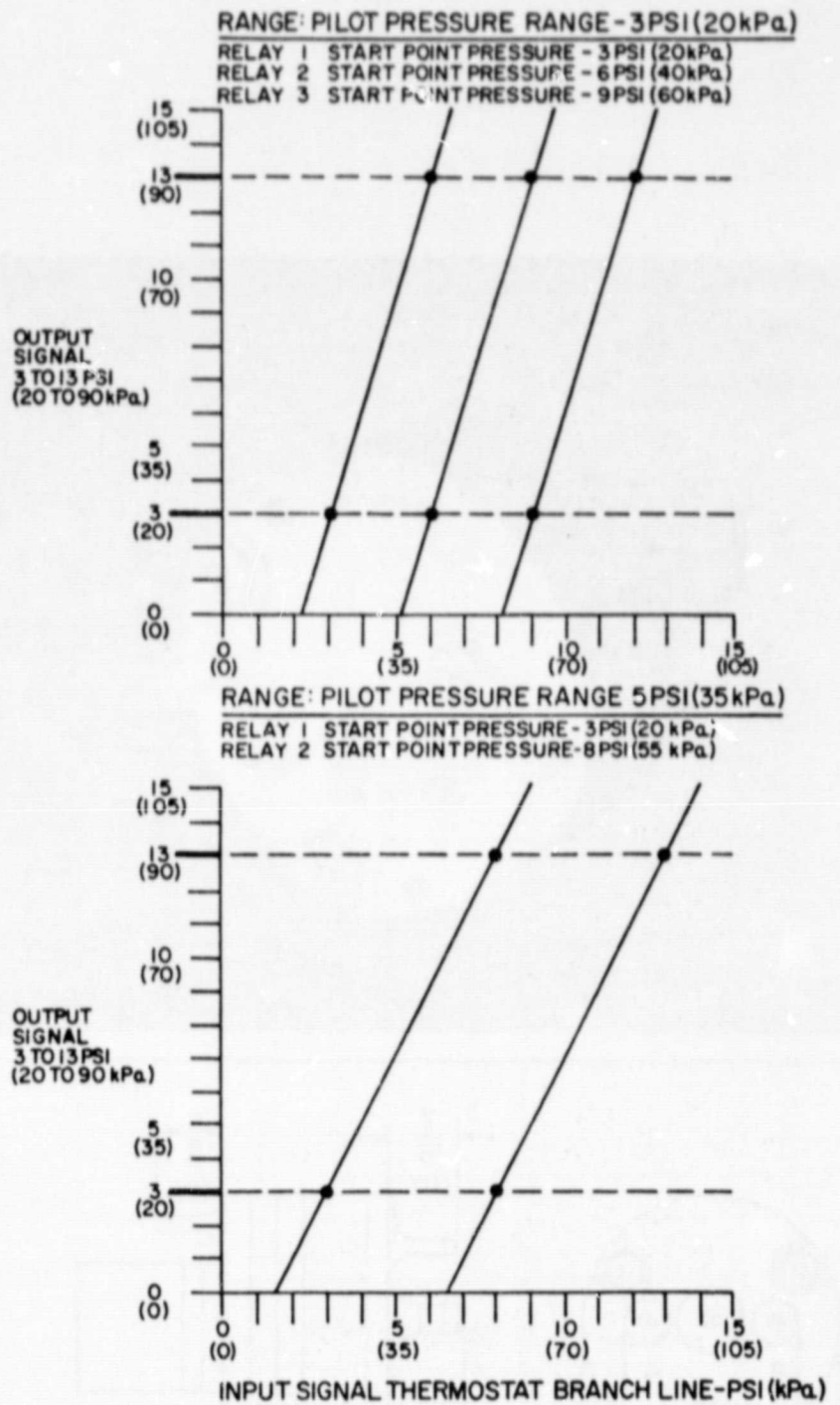


FIG. 2-TYPICAL OPERATION



77-9849-6

FIG. 3-TYPICAL APPLICATION SEQUENCING DAMPERS FROM A SINGLE THERMO-
STAT

Honeywell

Pneumatic Reversing Relay

MODEL NUMBER RP972A

General

The RP972A Pneumatic Reversing Relay is a modulating relay suitable for all types of heating and air conditioning control systems. It is used as a reversing relay to reverse and increase the capacity of the branch line pressure to the final control element.

Features

- Reverse acting.
- In-line mounting; or can be surface or panel mounted with standard 1-1/2 in. dia. cable clamp.
- Neoprene diaphragm.
- Stainless steel valve seats.

Specifications

MODEL

RP972A — Reverse acting, proportional output (branch line pressure decreases with increase in input signal at a 1:1 ratio). Device is factory set at 16 psi (1.1 bar, Scale B) but can be field set for 13 psi (.9 bar, Scale A) or 18 psi (1.2 bar, Scale C).

DIMENSIONS

Refer to Fig. 1.

OPERATING RANGE

0 to 18 psi (0 to 1.2 bar)

MAXIMUM SAFE AIR PRESSURE

30 psi (2.1 bar).

OPERATING PRESSURES

Pilot — 3 to 15 psi (.2 to 1 bar), Main — 18 psi (1.2 bar).

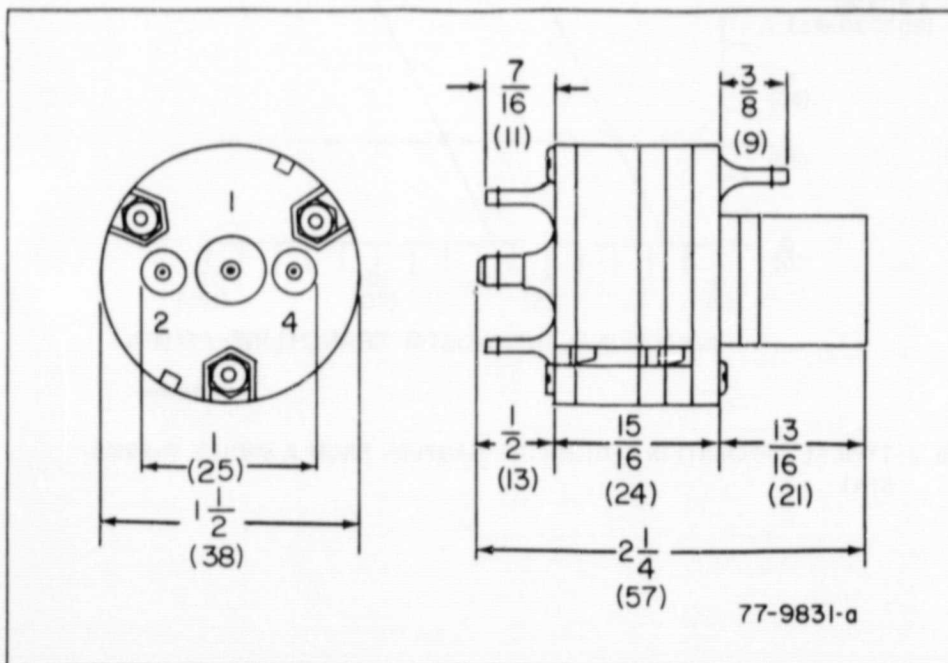
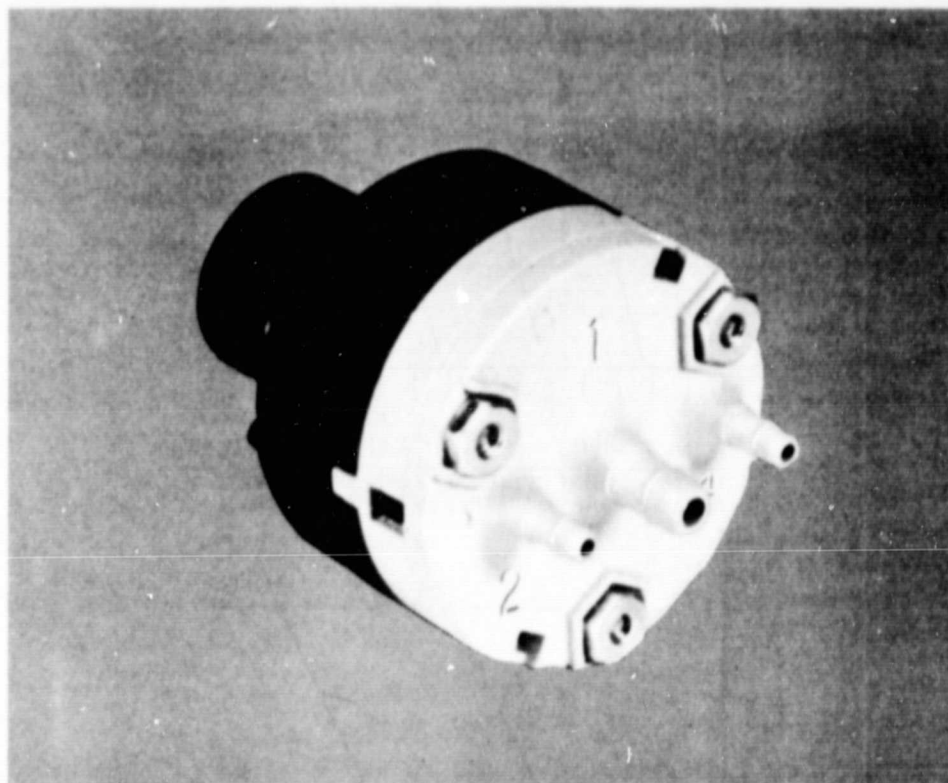


FIG. 1—APPROXIMATE DIMENSIONS OF RP972A IN INCHES (MILLIMETERS).

AMBIENT TEMPERATURE LIMITS

0 to 140F (-18 to 60C).

AIR CONNECTIONS

Port 1 (Main, Supply) - Sharp barb for 1/4 in. (6 mm) O.D. tubing. Ports 2, 3, and 4 (Branch, Output; Pilot, Input; and Exhaust, respectively) - Sharp barb for 5/32 in. (4 mm) O.D. tubing.

AIR HANDLING CAPACITY (Feed and Bleed)

0.039 scfm at 1.02 psi differential
(1,100 sccm at 0.07 bar differential).

AIR CONSUMPTION

0.0017 scfm (50 sccm) maximum.

FILTERS

100 mesh stainless steel, main and branch ports.

WHEN ORDERING, SPECIFY

Model Number.

Operation

When the relay is balanced the main and exhaust ports are closed and

branch line pressure is equal to the algebraic sum of the spring force plus force from pilot pressure.

As pilot pressure decreases (from thermostat branch line pressure on a fall in temperature) the RP972A increases its branch line pressure, causing a pneumatic operator to open a normally-closed valve or damper.

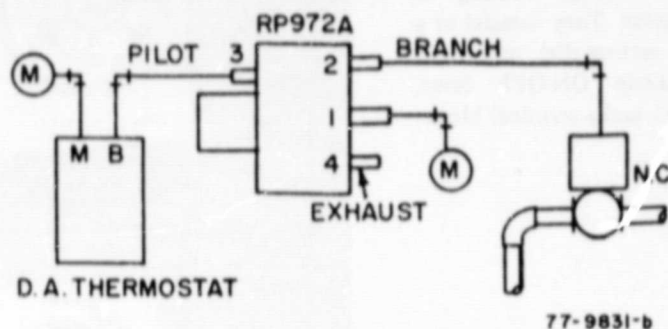


FIG. 2-TYPICAL OPERATION.

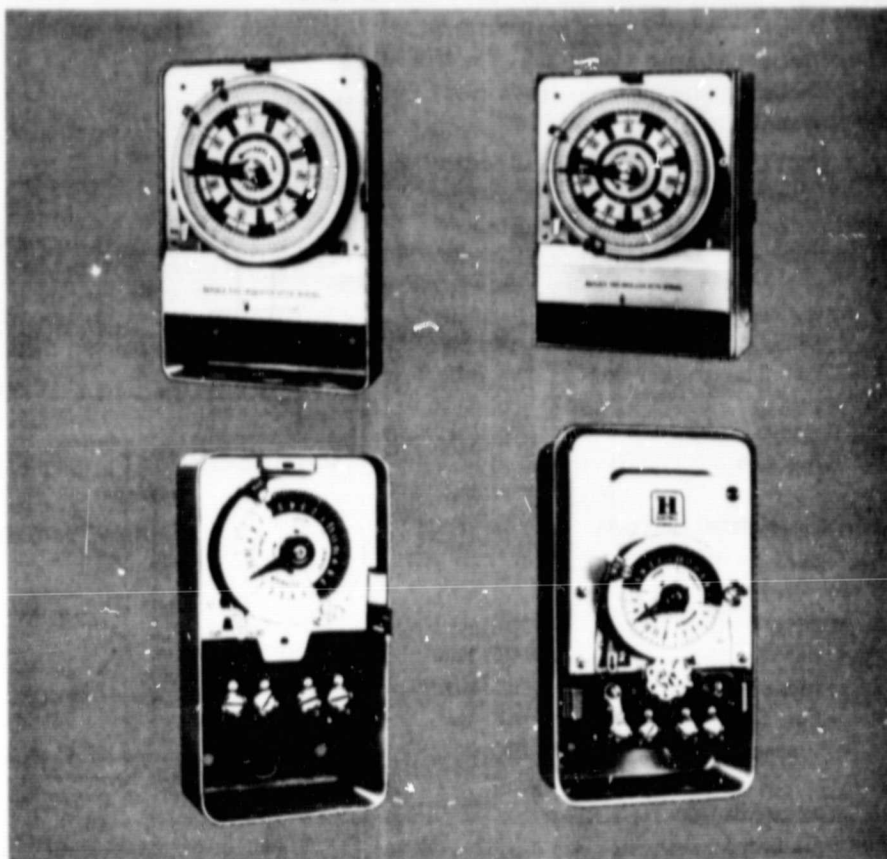
MODEL NUMBER S659A, B, C & E

General

The S659 Timers provide automatically timed electrical-switching functions for heating, cooling or ventilating systems. They consist of a timing motor, setting dial, adjustable trippers, hand-trip ON-OFF lever, control switches, and a terminal block.

Features

- Seven-day or twenty-four-hour programs.
- Easily adjustable.
- Spring carry-over in case of power failure.
- Skip-A-Day feature on the 24-hour models.



Specifications

TABLE 1. S659 SPECIFICATIONS

Model No.	Type	Skip-A-Day Feature	10-Hour Spring Carryover	On-Off Operations		Minimum Interval Between Operations	Switch Action	Case and Cover	Timing Motor Voltage and Frequency
				per day	per week				
S659A	7-day	-----	No	1 ^a	7 ^a	3 Hours	4P; 2P-NO, 2P-NC	With	120, 208, 240v; 60 Hz 208, 240v; 50 Hz
								Without	120, 208, 240v; 60 Hz
S659B	7-day	-----	Yes	1 ^a	7 ^a	3 Hours	4P; 2P-NO, 2P-NC	With or Without	120, 208, 240v; 60 Hz
S659C	24-hour	No	No	1 ^b	-----	90 Min	SPDT	With or Without	120, 208, 240v; 50/60 Hz
S659E	24-Hour	Yes	Yes	1 ^b	-----	90 Min	SPDT	With	120, 208, 240v; 60 Hz

^aMay be increased to four on-off operations per day, 28 per week, maximum by using extra trippers. See accessories.

^bMay be increased to seven on-off operations per day maximum by using extra trippers. See accessories.

SWITCH CONTACT RATING PER POLE
(AC Only)

	Motor Load (Amperes)		
	120v	208v	240v
Full Load	16	8	8
Locked Rotor	96	48	48

Resistive: 40 amps

Tungsten (for S659C & E only): 40 amps

Pilot Duty: 690 va

NOTE: For S659A & B with inductive loading, do not jumper switches to increase capacity beyond rating per pole as listed.

BAG ASSEMBLIES

S659A & B: Three terminal jumpers, six "A" (on) trippers and six "B" (off) trippers.

S659E: Three cut-out pins for Skip-A-Day feature.

DIMENSIONS

See Figures 1 through 7.

ACCESSORIES AVAILABLE

For S659A & B: No. 800740, two trippers, one "A" (on) and one "B" (off).
For S659C & E: No. 800741, two trippers, one "ON" and one "OFF".

APPROVALS

UL Listed.

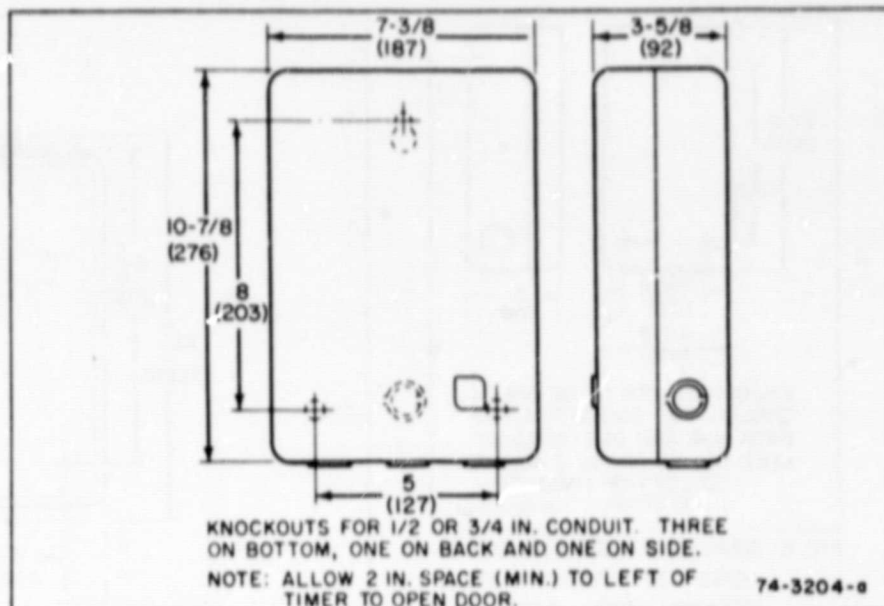


FIG. 1. S659A APPROXIMATE DIMENSIONS IN INCHES (MILLIMETERS) WITH CASE AND COVER

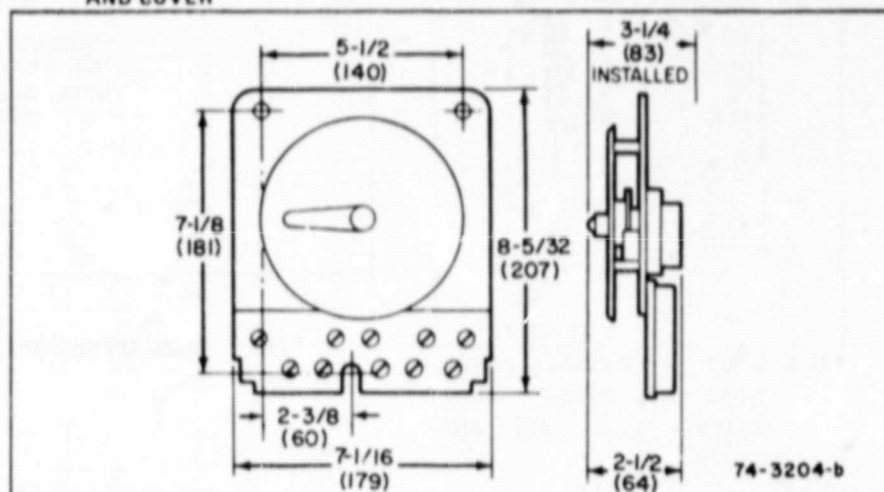


FIG. 2. S659A APPROXIMATE DIMENSIONS IN INCHES (MILLIMETERS) LESS CASE AND COVER

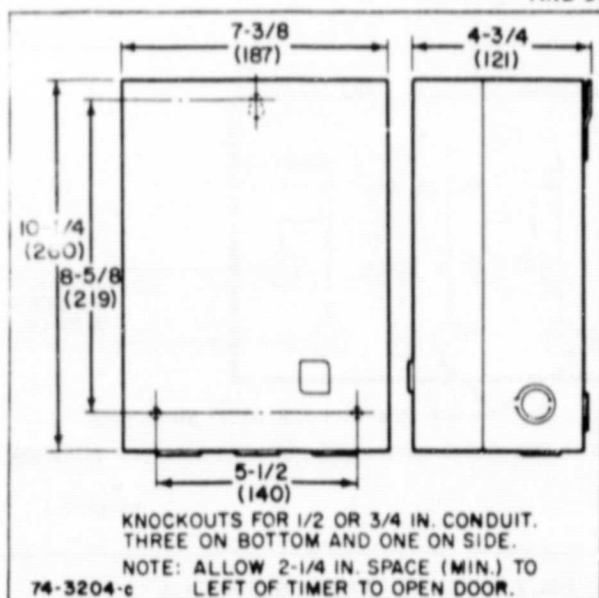


FIG. 3. S659B APPROXIMATE DIMENSIONS IN INCHES (MILLIMETERS) WITH CASE AND COVER

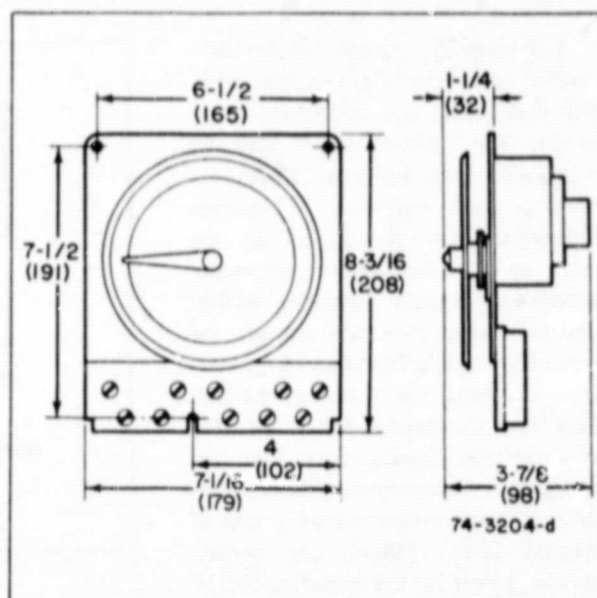


FIG. 4. S659B APPROXIMATE DIMENSIONS IN INCHES (MILLIMETERS) LESS CASE AND COVER

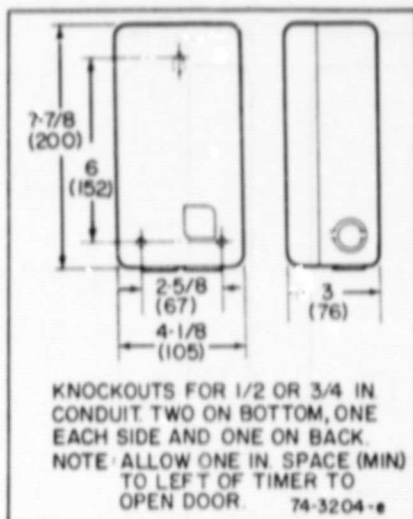


FIG. 5. S659C APPROXIMATE DIMENSIONS IN INCHES (MILLIMETERS) WITH CASE AND COVER

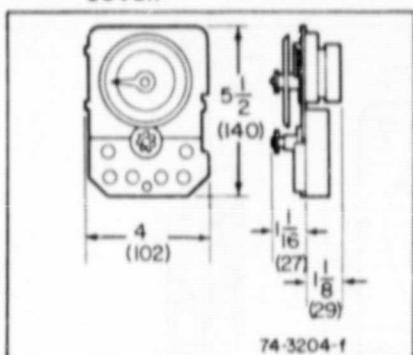


FIG. 6. S659C APPROXIMATE DIMENSIONS IN INCHES (MILLIMETERS) LESS CASE AND COVER

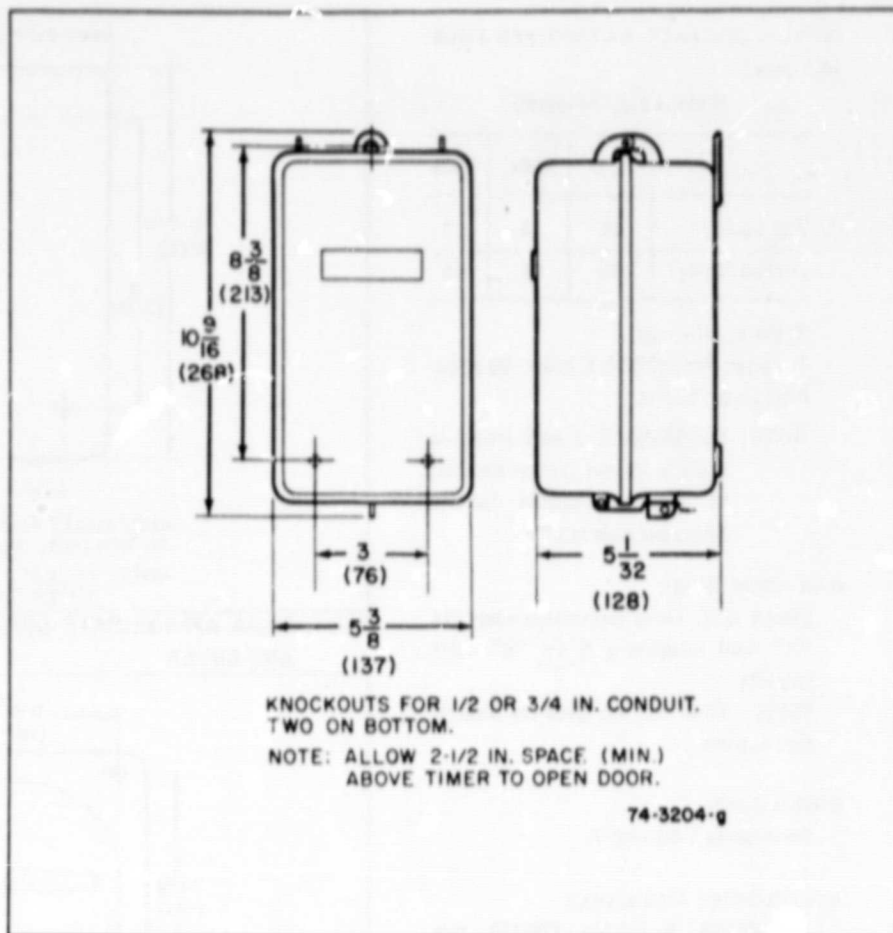


FIG. 7. S659E APPROXIMATE DIMENSIONS IN INCHES (MILLIMETERS)

Typical Operation

The seven-day model dials are subdivided into seven days of the week, day and night, and 30-minute increments. The 24-hour model dials are subdivided into morning, afternoon, evening, and night—and 15-minute increments. On-off trippers on the edge of the dial permit automatic switching; manual switching within one hour after automatic tripping for seven-day models, or within 15 minutes after tripping for 24-hour models. This lever also permits visual checking of automatic tripping status. Optional spring carry-over maintains clock movement (proper programming) in case of electric power failure. The spring-reserve power lasts a minimum of 10

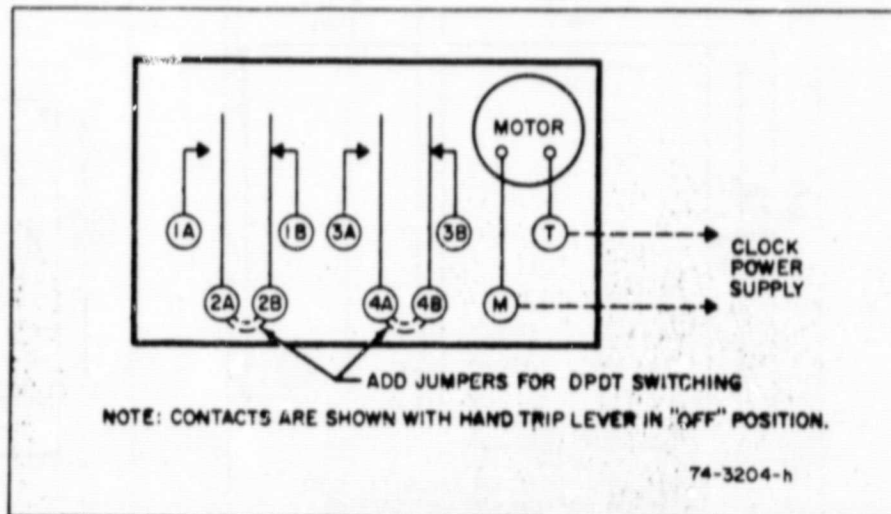


FIG. 8. S659A & B TYPICAL OPERATION

hours, and automatic rewind takes two hours on resumption of power. The Skip-A-Day feature, available on 24-hour models, eliminates operation on any preselected day or days of the week, and can be set up to a week in advance. This feature consists of an additional seven-day dial with cut-out pins to eliminate a selected day, or days. On the seven-day model, Skip-A-Day is accomplished by omitting selected trippers on the dial.

As a typical example, assume the timer is used in a system where it is desired to operate an air conditioner between 7:00 AM and midnight, and have continuous fan operation between midnight and 7:00 AM. (See Figs. 8 and 9.) At 7:00 AM the time

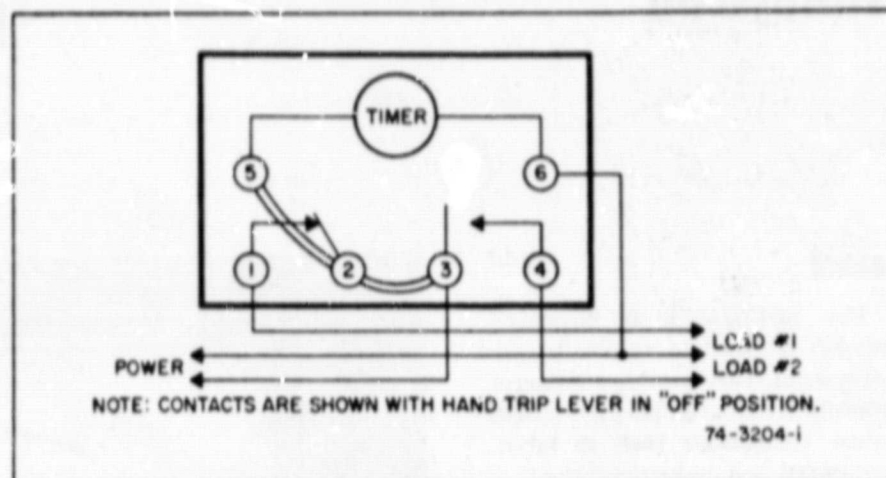


FIG. 9. S659C & E TYPICAL OPERATION

switches on the air conditioning equipment. At midnight the timer deenergizes the air conditioning circuit

and energizes the fan circuit until 7:00 AM the next morning, at which time the air conditioning circuit is energized.

General

The SP470A & B Pneumatic Switches are used in pneumatic control systems. They provide a means of manually diverting air between various system components such as valves, thermostats, and damper operators.

Features

The SP470A (pneumatic switch only) and the SP470B (pneumatic switch mounted on a panel) are available with two-position or three-position scaleplates. The SP470A is normally mounted on a panel which may be up to 7/16-inch (11 mm) thick. However, the device can be mounted on panels that are up to one-inch (25 mm) thick by using an optional extension.

Specifications

MODELS

SP470A - Pneumatic switch only.

SP470B - Pneumatic switch mounted on a panel.

NORMAL OPERATING PRESSURE RANGE

0 to 18 psig (0 to 125 kPa).

AIR HANDLING CAPACITY

0.175 SCFM at 1 psi drop (82.6 ml/s at 7 kPa drop)

MAXIMUM OPERATING PRESSURE

30 psig (205 kPa).

OPERATING AMBIENT LIMITS

Temperature - 0 to 140F (-18 to 60C).

Humidity - 5 to 95% RH.

AIR CONNECTIONS

Sharp barb type connections for 5/32 inch (4 mm) o.d. plastic tubing.

DIMENSIONS

Refer to Fig. 1 through Fig. 4.

CONSTRUCTION

Molded plastic switch body with Buna "N" seal disc.

Molded glass-reinforced nylon shaft.

ACCESSORIES (Order Separately)

Extension for mounting on panels up to one inch (25 mm) thick (315677A).

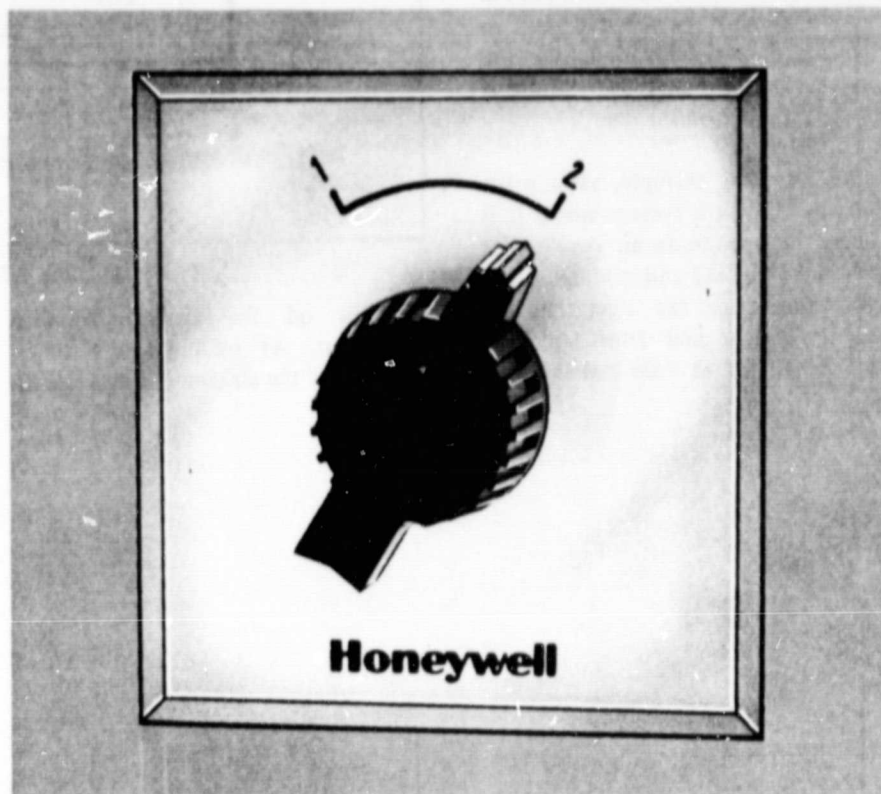
Bracket assembly for mounting the switch in a standard electrical box (316813A).

WHEN SPECIFYING, INDICATE

1. Model number.
2. Accessories desired.

Typical Operation

Switching action is accomplished by rotating the knob until a detent click is noticed (approximately 60 degrees). This causes the controller ports to align with the proper ports in the switch base, thus channeling air into the desired lines. All ports bleed to atmosphere when the switch is between positions. See Fig. 5 and Fig. 6.



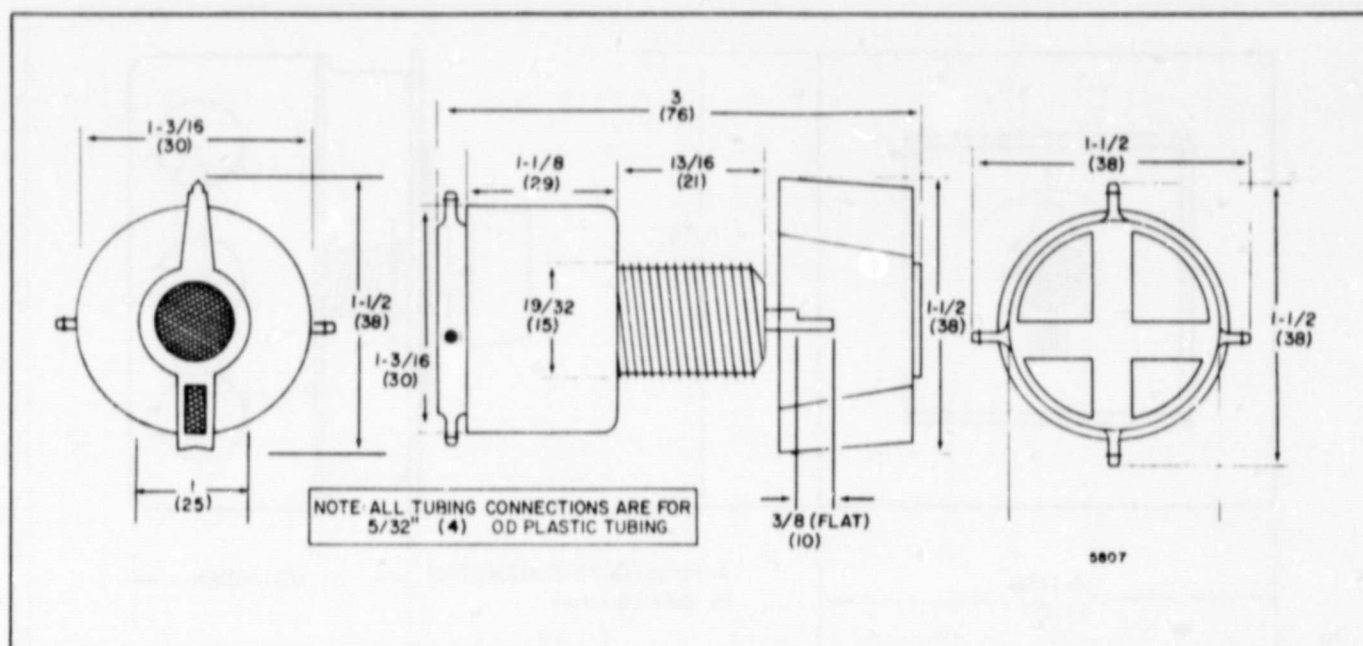


FIG. 1—APPROXIMATE DIMENSIONS IN INCHES (MM)

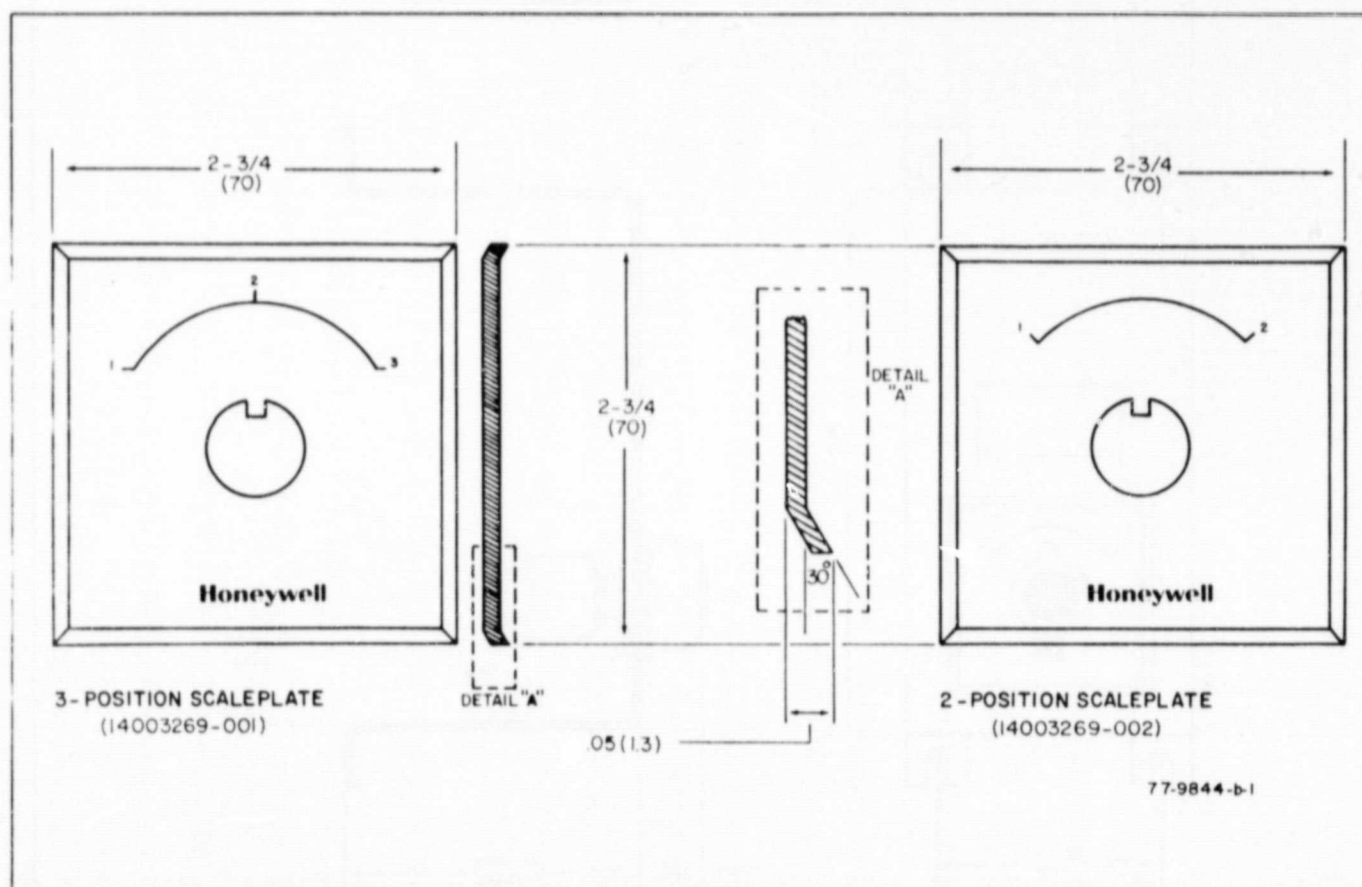


FIG. 2—APPROXIMATE DIMENSIONS IN INCHES (MM)

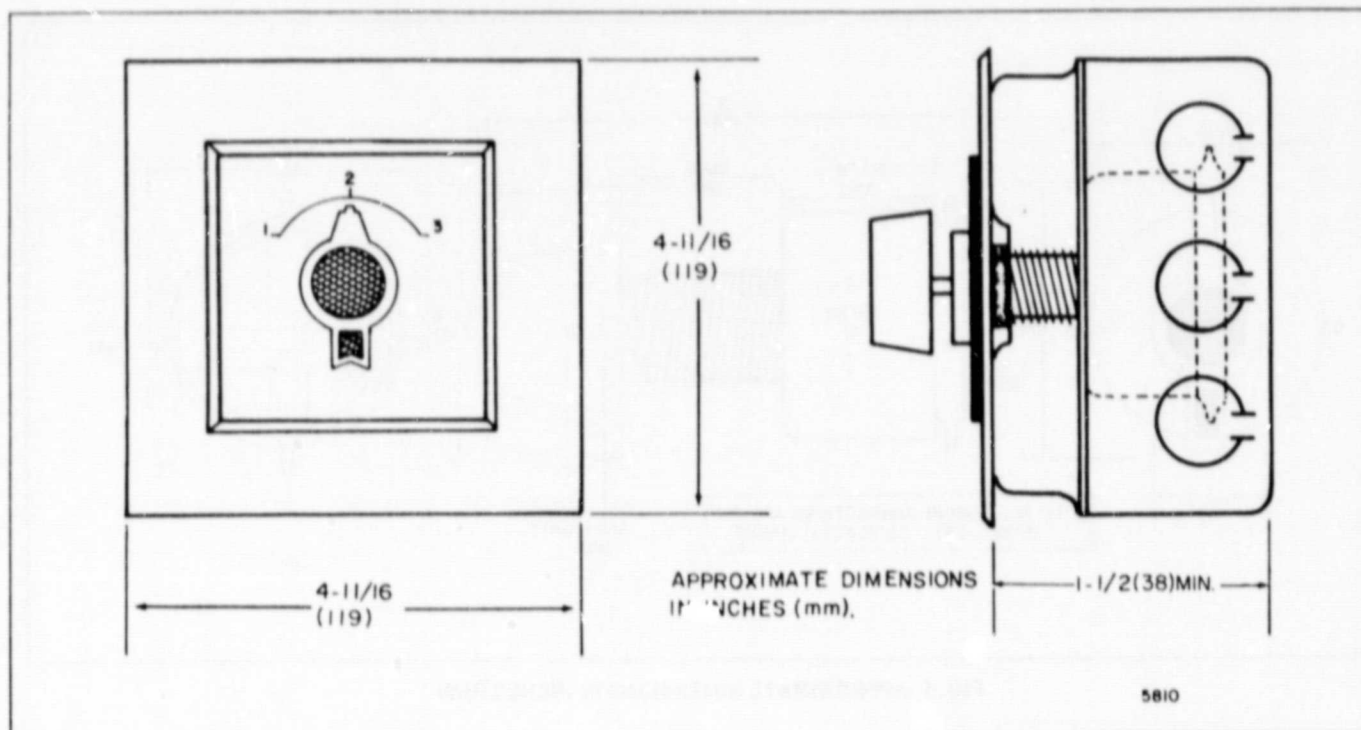


FIG. 3-SP470 SHOWN MOUNTED IN AN ELECTRICAL BOX (RACO NO. 245 OR EQUAL) USING KIT NO. 316813A.

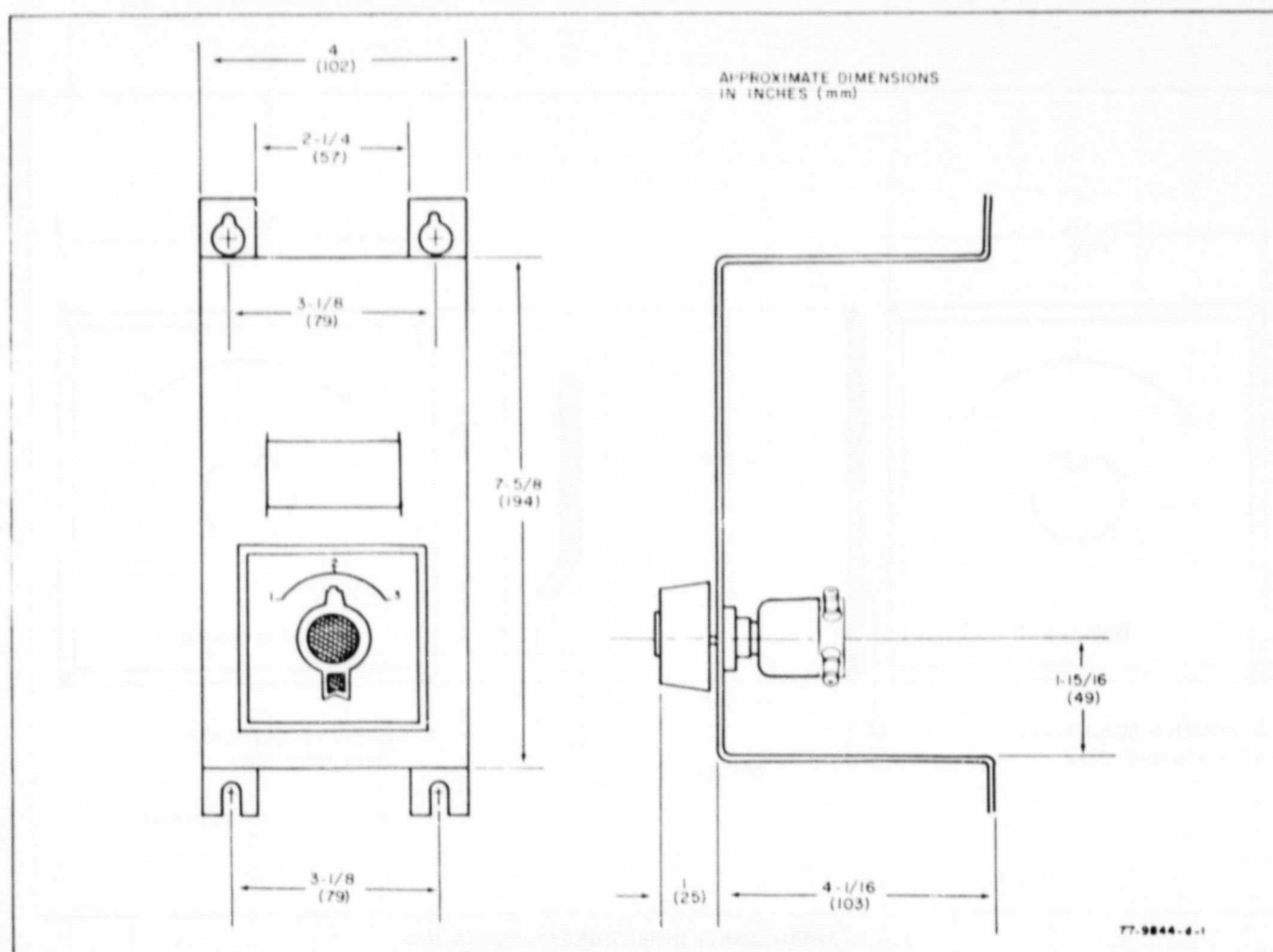
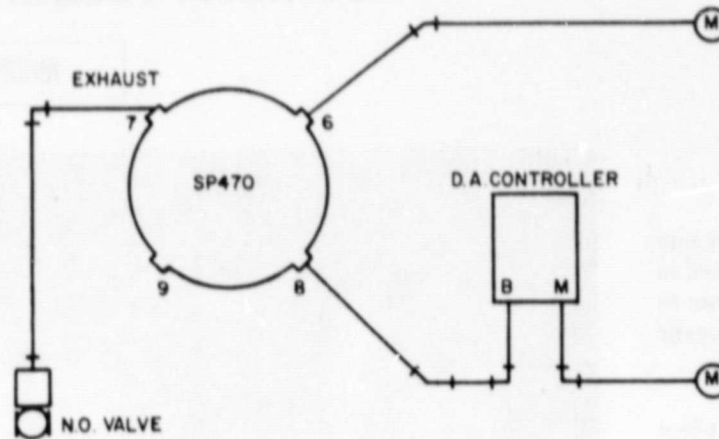


FIG. 4-SP470B (MOUNTED ON A PANEL)

THREE POSITION SWITCH



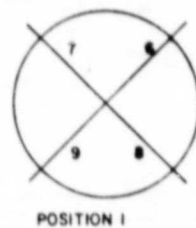
- POSITION 1 - PORTS 7 & 9 CONNECTED; PORTS 6 & 8 BLOCKED; VALVE OPEN.
- POSITION 2 - PORTS 7 & 8 CONNECTED; PORTS 6 & 9 BLOCKED; VALVE AUTO.
- POSITION 3 - PORTS 7 & 6 CONNECTED; PORTS 8 & 9 BLOCKED; VALVE CLOSED.

77-9844-s-1

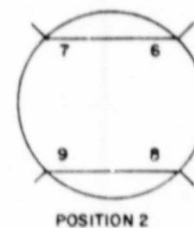
FIG. 5-TYPICAL CONNECTIONS

SWITCHING ACTIONS:

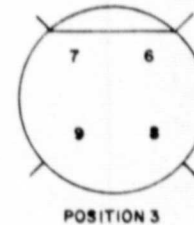
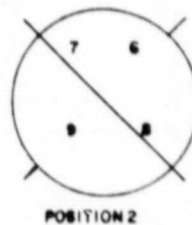
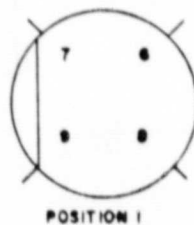
TWO POSITION MODELS-



CIRCUIT INTERCHANGE



THREE POSITION MODELS-



NOTE: DISCONNECTED PORTS BLOCKED

5811

FIG. 6-TWO-POSITION AND THREE-POSITION SWITCHING ACTIONS

Manual & Minimum Position Pressure Regulator

MODEL NUMBER SP970A-D

General

The SP970 Manual or Minimum Position Pressure Regulator is used in HVAC systems to regulate pressure to an output device such as a pneumatic damper operator.

Port 4 on the switch may be piped to an input device to provide external override of the manual setting.

Features

- Sharp barb connections for 5/32 in. (4 mm) OD plastic tubing.
- Molded plastic construction with neoprene diaphragm, music wire spring, and steel shaft.
- Two range spans available.
- Pilot bleed and isolated pilot models available.
- Wall or panel mounting.

Specifications

MODELS

SP970A: Three-port pneumatic manual or minimum position switch with pilot bleed and 5 or 10 lb/in² (34 or 69 kPa) spans available (convertible to 8 or 16 lb/in² [55 or 110 kPa]).

SP970B: Same as SP970A but with wall mounting bracket.

SP970C: Four-port pneumatic switch with isolated pilot chamber and 10 lb/in² (69 kPa) span, for use with capacity or bleed-type controllers.

SP970D: Same as SP970C but with wall mounting bracket.

DIMENSIONS

Refer to Fig. 1, 2 and 3.

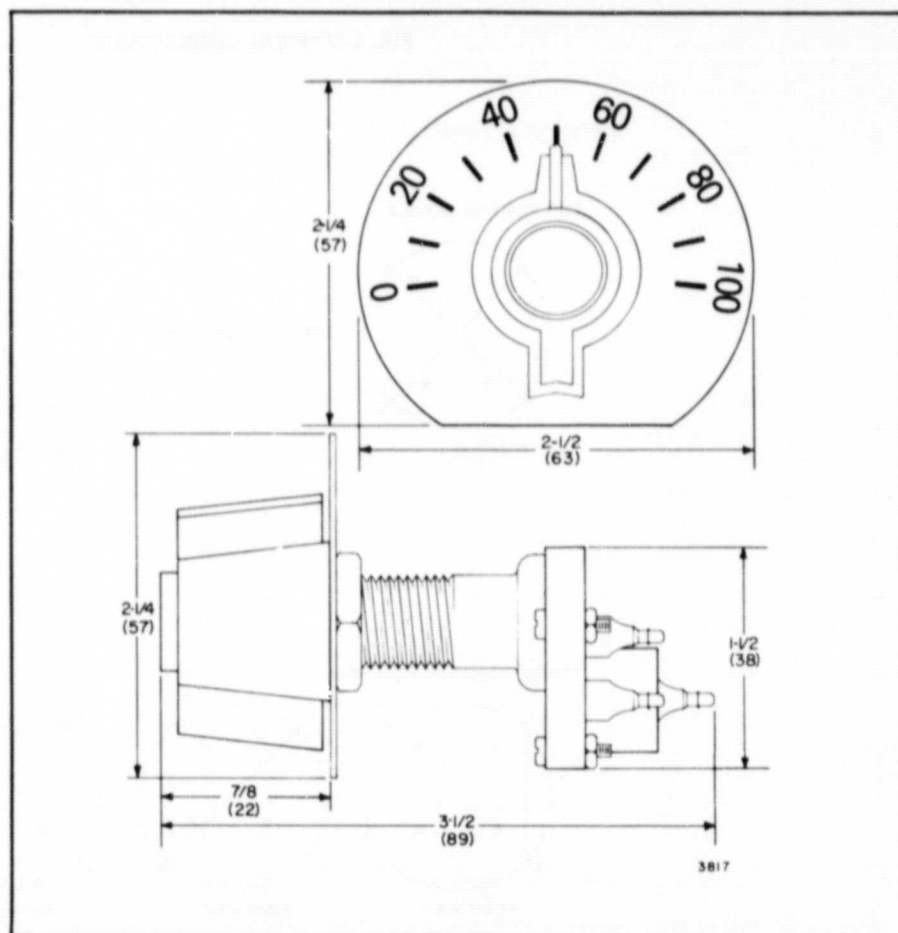
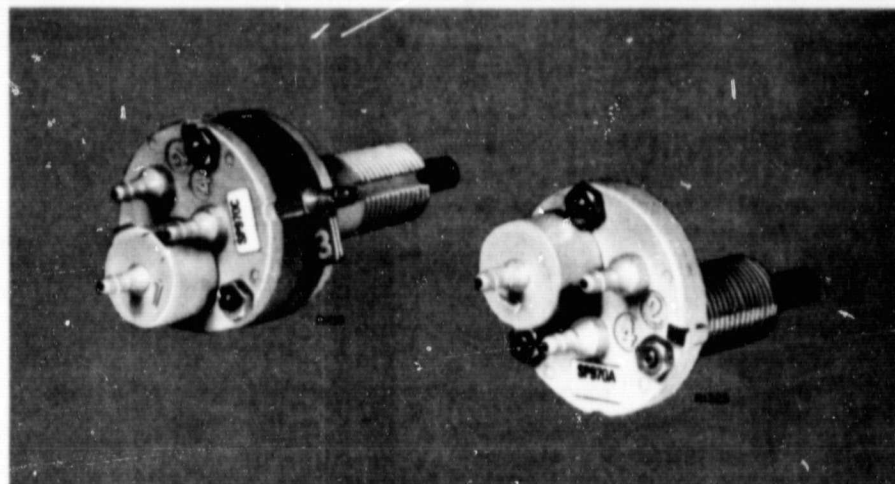


FIG. 1. SP970A APPROXIMATE DIMENSIONS IN INCHES (MILLIMETERS) WITH SCALEPLATE AND KNOB ATTACHED

MOUNTING

SP970A and C: Normally panel mounted. See ACCESSORIES for spring clip or cable clamp required for wall mounting without scaleplate.

SP970B and D: Wall mounted. Bracket has four 1/4 in. (6 mm) slots for mounting.

OUTPUT

The large range model spans 10 lb/in² (69 kPa) with 188 degree knob rotation, or 16 lb/in² (110 kPa) with 300 degree maximum knob rotation. The small range model spans 5 lb/in² (34 kPa) with 188 degree knob rotation, or 8 lb/in² (55 kPa) with 300 degree maximum knob rotation.

NOTE: The knob has two break-away stops that limit rotation to 188 degrees. Each stop, when broken away, adds 56 degrees of rotation (300 degree maximum).

OPERATING PRESSURES

Main (Supply, Port 1): 18 lb/in² (125 kPa).

Branch (Output, Port 2): 3 to 15 lb/in² (21 to 103 kPa).

Pilot (Input, Port 3 on SP970C and D. Input, Port 4 on SP970A and B): 3 to 15 lb/in² (21 to 103 kPa).

MAXIMUM SAFE AIR PRESSURE

30 lb/in² (207 kPa).

AIR CAPACITY

SP970A and B: 0.004 standard ft³/min (1.7 mQ/s), below minimum position. Above minimum position, device feeding pilot determines capacity.

SP970C and D: 0.004 standard ft³/min (1.7 mQ/s).

AIR CONSUMPTION

0.022 standard ft³/min (10 mQ/s).

SCALEPLATE

All models shipped with 0 to 100 F scaleplate (including knob and locknuts) unless otherwise specified (see ACCESSORIES).

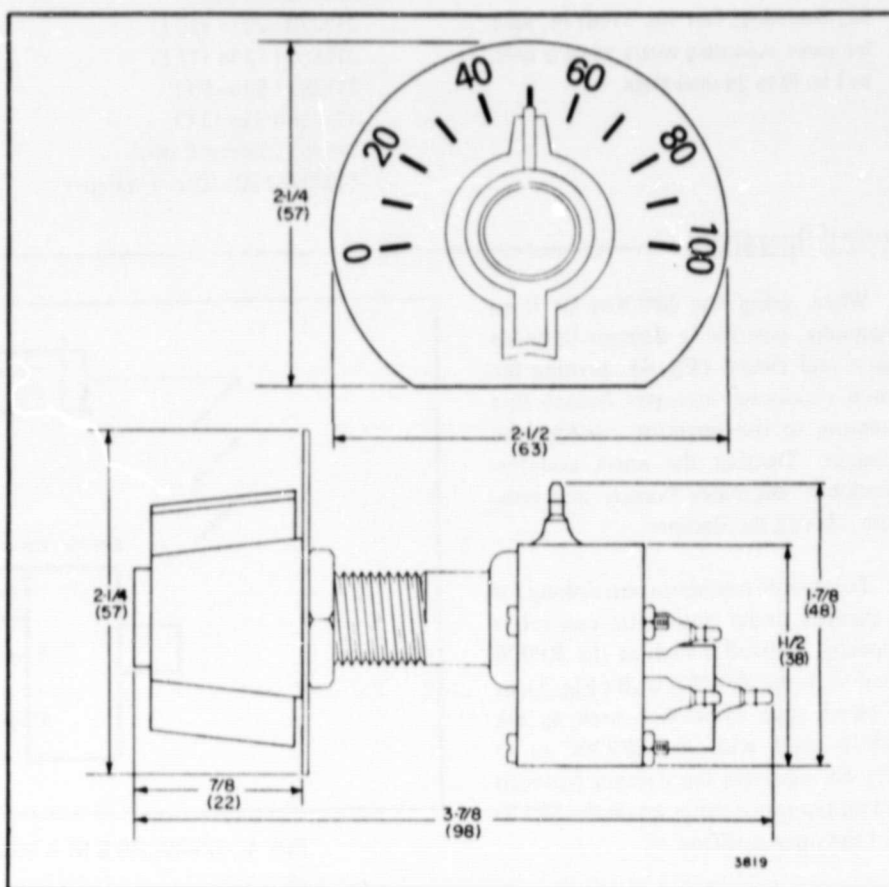


FIG. 2. SP970C APPROXIMATE DIMENSIONS IN INCHES (MILLIMETERS) WITH SCALEPLATE AND KNOB ATTACHED

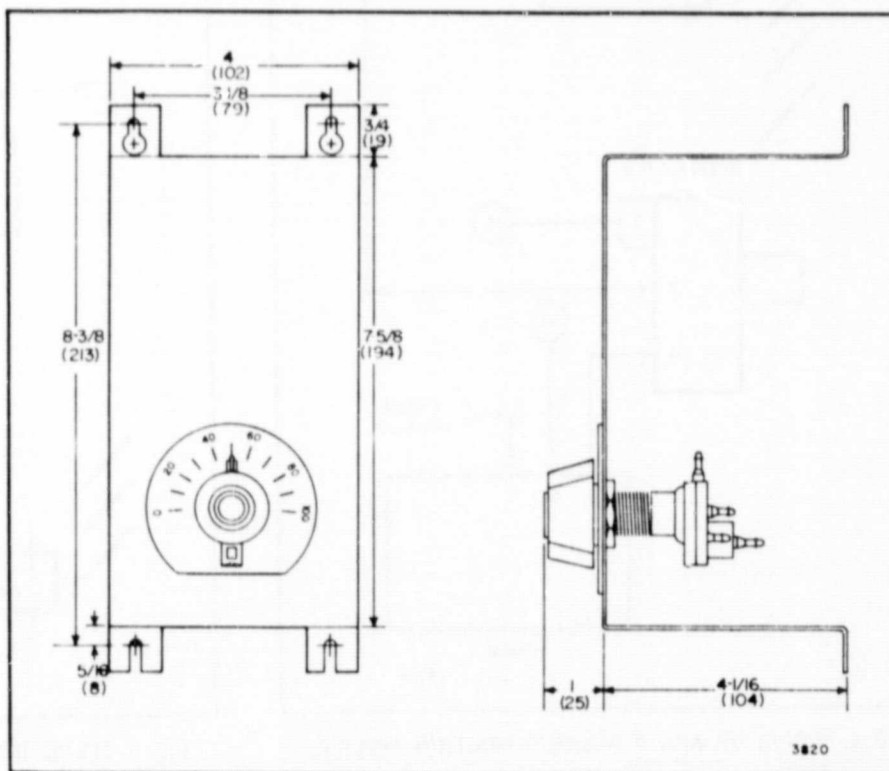


FIG. 3. SP970B AND D APPROXIMATE DIMENSIONS IN INCHES (MILLIMETERS) WITH SCALEPLATE AND KNOB ATTACHED

ACCESSORIES

Bag Assembly, Part No. 315677A, used for panel mounting where panel is 5/16 to 1 in. (8 to 25 mm) thick.

Available Scaleplates:

315326 (-20 to +20 F)
315554 (-12 to +12 C)
315757 (-5 to +5 F)
315758 (-3 to +3 C)
315787 (Warmer-Cooler)
14003762-001 (Cooler-Warmer)

Spring Clip (Part No. 14003030-001).

Cable Clamp (Part No. 801629S).

WHEN ORDERING, SPECIFY

Model Number.

Accessories Required.

Typical Operation

When using the SP970A or B to manually position a damper between open and closed (Fig. 4), turning the knob clockwise increases branch line pressure to the operator, opening the damper. Turning the knob counter-clockwise decreases branch line pressure, closing the damper.

To provide minimum positioning for a damper under automatic control, a capacity controller such as the RP908 used with the SP970A or B (Fig. 5), or a bleed type controller such as the LP916 used with the SP970C or D (Fig. 6) operates the damper between the minimum position set on the SP970 and the open position.

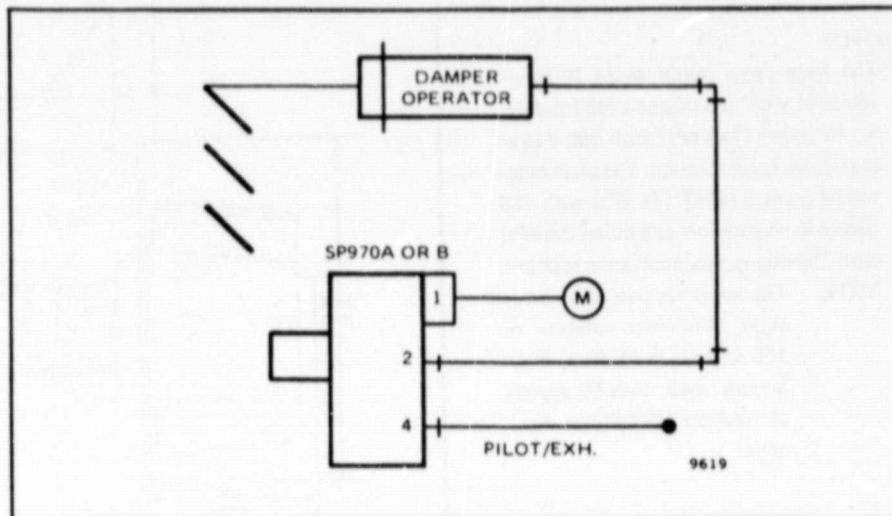


FIG. 4. SP970A OR B IN A MANUAL POSITION APPLICATION

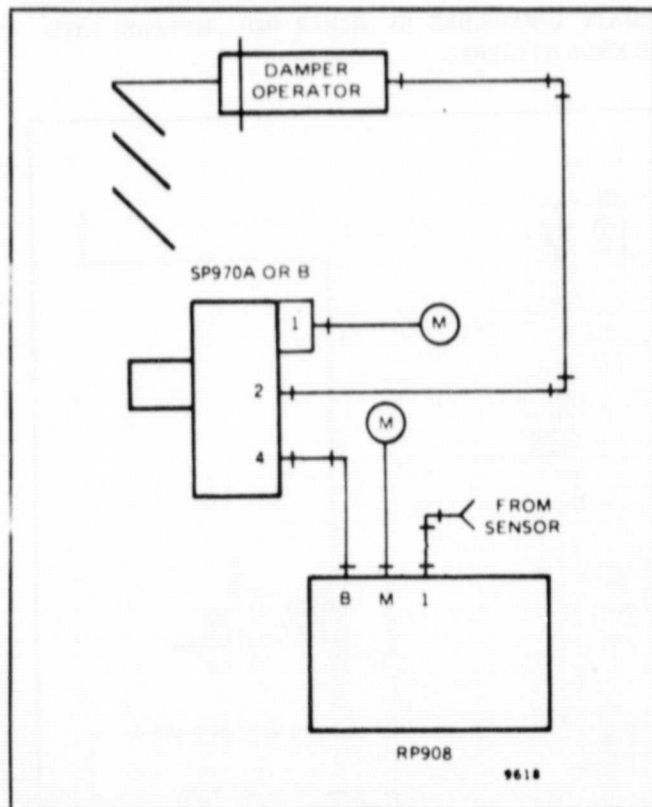


FIG. 5. SP970A OR B IN A MINIMUM POSITION APPLICATION

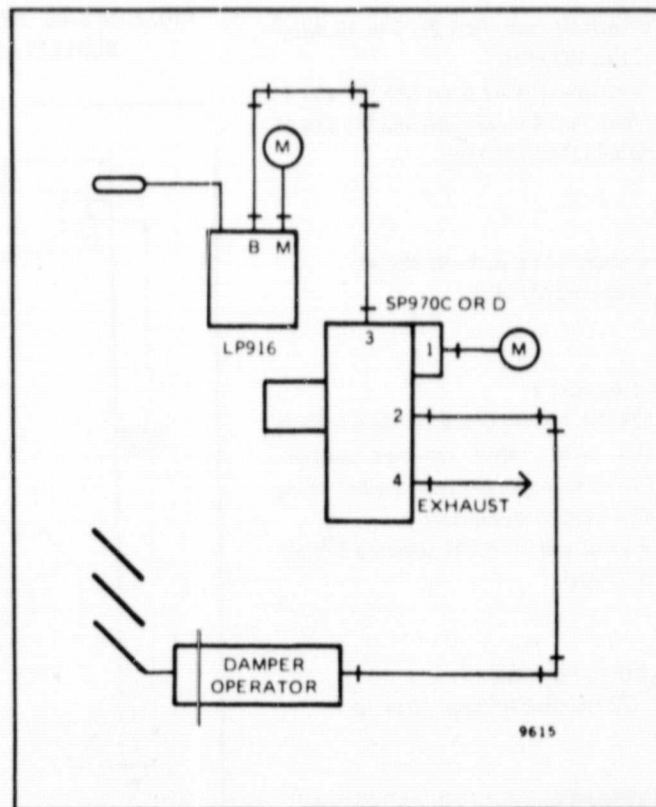


FIG. 6. SP970C OR D IN A MINIMUM POSITION APPLICATION WITH A BLEED TYPE THERMOSTAT (LP916) INPUT

APPENDIX C

Manufacturers Literature

Marley Cooling Tower



COOLING TOWER OPERATING MANUAL

prepared for YOUNG PLUMBING & HEATING CO.

for: KAW VALLEY BANK

TOPEKA, KANSAS

Tower Model No.	6325
Tower Serial No.	
Customer Order No.	1462
Marley Order No.	KC-82-77

Please refer to Marley Order Number and Tower Serial
Number in correspondence concerning this tower.

We shall be happy to quote current parts
prices and shipment upon request.

THE MARLEY COOLING TOWER COMPANY
5800 Foxridge Drive, Mission, Kansas 66202



MANUAL

AQUACOOLED



Installation, Operation and Maintenance Instructions

MODELS

6320	6340	6375
6325	6350	6380
6330	6360	6390

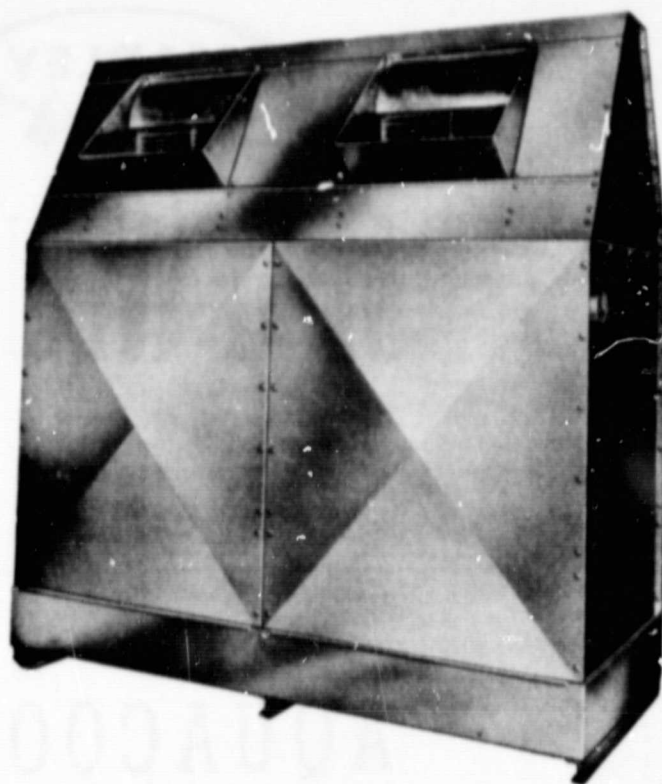
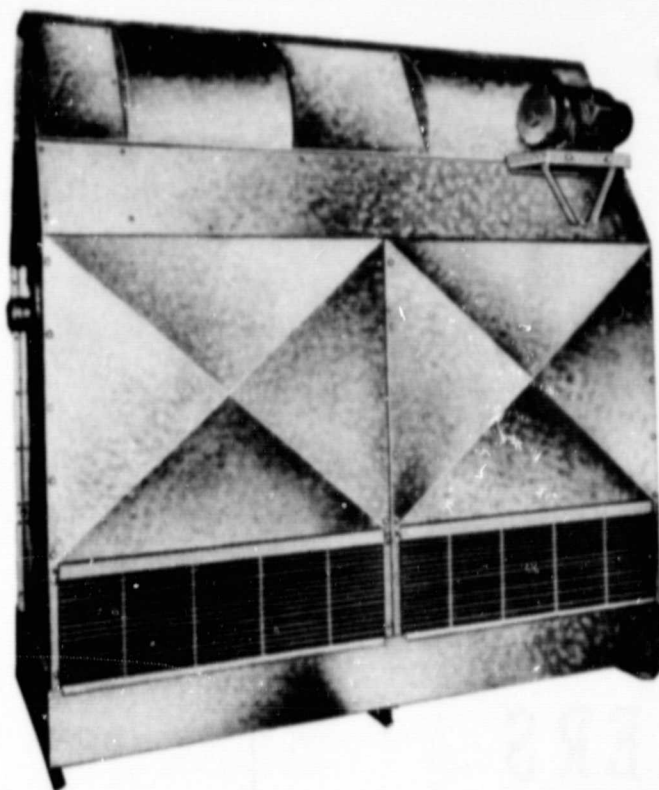
ALWAYS REFER TO TOWER SERIAL NUMBER WHEN WRITING FOR INFORMATION OR ORDERING PARTS FOR THIS AQUACOOLED. SERIAL NUMBER IS STAMPED ON TOWER NAME PLATE LOCATED ON FAN SECTION NEAR MOTOR.

NOVEMBER, 1976

OM-6320-6390

5800 Foxridge Drive — P.O. Box 2912 — Mission, Kansas 66201

INSTALLATION, OPERATION AND MAINTENANCE — AQUACOOLED



AQUACOOOLER

Installation, Operation and Maintenance Instructions

TOWER PLACEMENT

TOWER LOCATION

Locate tower to obtain the least obstruction to the free flow of air to and from the unit. Allow adequate clearance on all sides of tower for maintenance.

INDOOR INSTALLATION

An indoor installation requires a discharge duct from the fan to the outside of the enclosed space. Ducts impose an additional draft loss that must be overcome by the fan. Care should be taken to insure that this external static pressure does not exceed 0.25 inches of water. Draft losses can be minimized by:

- Using 20% oversize ducts.
- Avoiding sharp turns, abrupt changes in duct size, and using turning vanes where necessary.
- Keeping length of the ducts to a minimum.
- Increasing the area of openings covered by screens, grids or louvers so the net free area is at least 20% greater than the fan discharge opening area.

Moisture from condensation inside the duct work may be a problem. The following will help control this:

- Insulate the duct work to minimize condensation.
- Seal duct work seams so that condensation will not drain outside.
- Slope duct work to drain condensation back into tower.

To maintain a low-operating sound level and to prevent transmission of noise through the ducts, the ducts should be connected to the tower with a flexible connection of rubber or canvas and should not be supported by the tower.

OUTDOOR INSTALLATION

Orient tower so the prevailing wind will blow into the air inlets. The fan section should be located with the air discharge opposite to the air inlet side.

POSITIONING AND ANCHORING TOWER

Tower must be installed in a *level position* to operate properly. Preliminary leveling may be done on the tower casing. After piping is completed, the level should be rechecked by placing a level on the top of the honeycomb fill (inside of tower) and placing shims under the tower skids if required.

Tower should be placed on a firm foundation and suitably anchored. Locate anchor clips (to be furnished by customer) at the hoisting holes in the tower skids and attach with 1/2" bolts. Bolt clips to foundation.

TOWER ASSEMBLY AND INSTALLATION

NOTE: Hex head machine bolts are used to attach access panels and may be removed without affecting tower alignment or structural stability. DO NOT remove round head bolts unless absolutely necessary.

GENERAL — The AquaCooler is shipped in three packages. Fill and basin section, fan section and the motor. A hardware and miscellaneous parts carton is shipped in the fan section.

STEP 1 — Remove the protective crating from the fill and basin section. Unbolt and remove shipping skids from the underside of the fan section. *Do not remove shipping blocks from the fan opening at this time.*

STEP 2 — Place fill and basin section in position on foundation.

STEP 3 — Lift fan section and place in position on the fill and basin section. Remove fan shipping blocks. Bolt fan section to fill and basin section with hex head bolts, lock washers and nuts.

STEP 4 — Assemble motor support (see Drawing No. 2) and install motor, belt adjusting angle and bolts. Check motor nameplate to be sure voltage, phase and frequency ratings are the same as the power supplied.

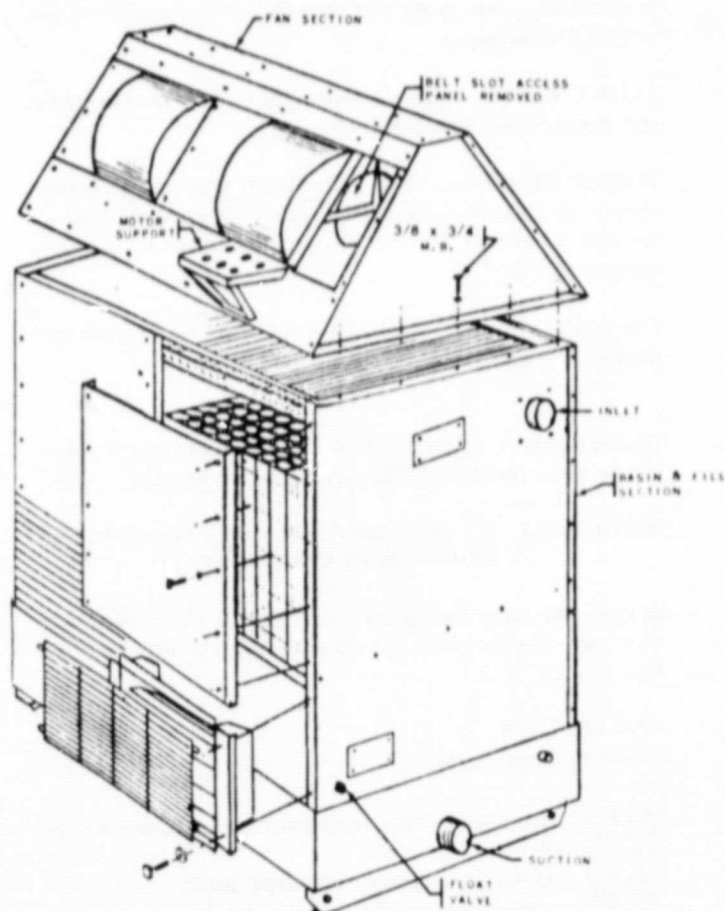
STEP 5 — Remove the belt slot access panel. Install the adjustable pitch sheave on the motor shaft. Sheave should be adjusted to the minimum pitch diameter by unscrewing the adjustable half of sheave until the shoulder of the adjustable half is flush with the end of the fixed half. Tighten set screw. Align motor sheave with the fan sheave located in the tower. This can be done with a straight edge across the fan sheave face. Rotate sheaves 1/4 turn and recheck alignment. Tighten set screw on motor sheave.

STEP 6 — Install V-belt and tighten motor adjusting bolts until V-belt is taut. Do not overtighten or the motor bearings may become overloaded. *Recheck belt tension* after tower has been in operation 8 hours.

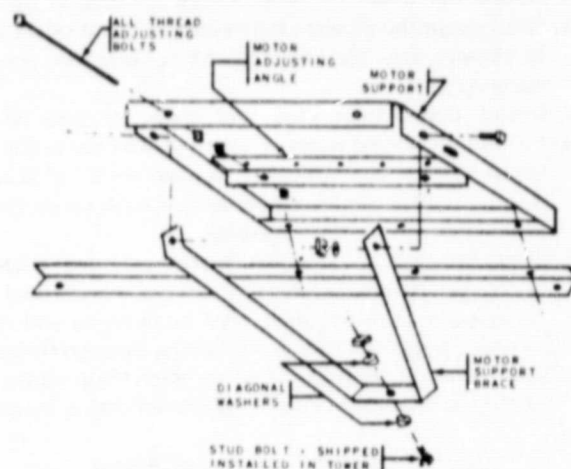
STEP 7 — Replace belt slot access panel. Install belt slot seal plate and belt guard using sheet metal screws furnished. See Drawing No. 3.

STEP 8 — Connect tower piping. Install bleed-off connection. (See bleed-off table on page 8.) It is recommended that short lengths of rubber hose be used to connect piping to tower to eliminate possibility of transmitting mechanical noise through the piping. If tower is installed outdoors, provide drain plugs in all water lines to prevent freezing during the winter months.

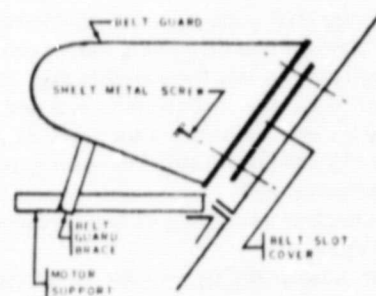
STEP 9 — Install the float valve through the hole in the casing end sheet and secure with the pipe locknut furnished with the float valve. Adjust float ball so valve shuts when



Drawing No. 1 — Tower Assembly



Drawing No. 2 — Motor Base Assembly (Step 4)



Drawing No. 3 — Belt Guard Assembly (Step 7)

water level reaches 5" in the basin.

STEP 10 — Install drain plug in bottom of basin, or pipe overflow and drain to the sewer.

STEP 11 — Wire motor. All motor wiring switching and overcurrent protection should be in accordance with the National Electrical Code or local requirements. Motor shaft must rotate clockwise when facing the end opposite the shaft extension. Direction of rotation may be reversed by interchanging any two of the three motor leads on a 3-phase motor.

NOTE: Motors above 1 horsepower do not have overload protection. They must be protected by dual element fuses or overload relay heater.

The magnetic starter (not furnished by Marley) usually contains overload relay heaters. Check your starter to see if this protection is incorporated or if you must furnish it separately.

TOWER IS NOW READY FOR START-UP.

START-UP INSTRUCTIONS

1. Check all electrical and piping connections for tightness.
2. Check fan openings to see that all shipping blocks and hardware have been removed.
3. Rotate fan wheel by hand. Check for drag or binding.
4. Wash down the asbestos honeycomb fill and tower basin to remove any accumulated debris. Use low pressure water stream.
5. Install basin drain plug and close all pipe drains.
6. Fill the circulating water system and start the pump. Re-adjust float valve if necessary to maintain 5" of water in the basin when pump is operating. Check spray system to see if all nozzles are operating.
7. Start fan motor. Recheck motor and fan rotation.
8. Check the motor voltage and current. All air inlet and outlet duct work (if used) must be installed and ready for use. *A/ways* start water circulating through the tower before current readings are taken. With these values, calculate the load horsepower with the following equation:

$$\text{Load Hp} = \frac{\text{Actual Volts} \times \text{Actual Amps}}{\text{Rated Volts} \times \text{Rated Amps}} \times \text{Rated Hp}$$

If the load horsepower determined by the above equation is less than the name plate horsepower, it must be adjusted by increasing the pitch diameter of the motor sheave. Remove the belt guard, loosen the motor adjustment bolts and screw the movable part of the sheave in (1/4 turn at a time). Tighten set screw and motor adjustment bolts and recheck motor load. Continue in this manner until motor is loaded to name plate horsepower. Reinstall belt guard.

9. Check bleed-off to make sure water is being discharged into overflow.
10. TOWER IS NOW READY FOR OPERATION.

MECHANICAL EQUIPMENT

MOTOR. Motor warranty covering manufacturer's material

and workmanship is for one year from date of delivery. Consult the yellow pages of your telephone directory for an authorized motor repair station to make in-warranty repairs.

Motor manufacturers classify cooling tower motors as "Severe Duty Application". Lubricate the motor according to the motor manufacturer's instructions. In general, these instructions are as follows:

1. Grease motor while in operation unless this would create a hazard.
2. Remove grease and relief plugs.
3. Free relief hole of any hardened grease.
4. Add new grease recommended by motor manufacturer until it comes out the relief.
5. Replace fill plug and operate motor approximately 30 minutes with relief open to expel excess grease.
6. Replace relief plug.

Do not mix greases of different type or specification. Flush bearing and housing if change of grease is desired.

FAN BEARINGS. Fill oil cup after 1000 hours operation or every two months (whichever occurs first.) See Bearing Lubrication Instructions on page 9.

V-BELTS AND SHEAVES. If belts slip, adjust belt tension. If necessary, clean belts and sheaves with soapy water. Do not use belt dressing.

FLOAT VALVE. Check periodically for proper operation and maintenance of water level.

TOWER GENERAL. Cold water basin and suction screen should be cleaned as required. Spray system should be inspected frequently for proper operation. Inspection openings are provided.

Fill and eliminators should be inspected once a year and cleaned if required.

DISASSEMBLY PROCEDURE (To Be Used Only If Aqua-Cooler Must Be Moved Through A Small Opening)

IMPORTANT: DO NOT DISASSEMBLE AQUACOOLER MORE THAN IS NECESSARY.

NOTE: As each part is removed, attach the fasteners to that part. Group parts as they are removed for identification.

FAN SECTION

(Refer to Drawing No. 9)

STEP 1 — Remove all hex head machine bolts and lift off access panels.

STEP 2 — Unbolt and remove top cover sheet.

STEP 3 — Unbolt and remove fan end sheets.

STEP 4 — Unbolt and remove motor support angle.

STEP 5 — Unbolt and remove both lower side sheets.

NOTE: On the one-fan towers, further disassembly should not be required. If further disassembly is **ABSOLUTELY** required, proceed as listed for a two-fan tower.

STEP 6 — On two-fan towers, check to see if disassembled section can be moved into place. If not . . .

STEP 7 — Remove fan sheave. This is accomplished by removing the cap screws in the sheave hub and installing them in the open tapped holes in the hub. Tightening the cap screws will then force the sheave off the hub. When the sheave is free, the hub can then be pulled off the shaft.

STEP 8 — Disconnect oil lines from the bearing housings.

STEP 9 — Support fan shaft and remove the self locking nuts used to attach the bearings to their support.

STEP 10 — Loosen the set screws on the fan wheel hub furthest from the sheave end of the shaft and pull fan and housing free of the fan shaft.

CHECK AGAIN TO SEE IF SECTION CAN BE MOVED INTO POSITION. FURTHER DISASSEMBLY REQUIRES REMOVAL OF THE BEARING ASSEMBLIES WHICH SHOULD BE AVOIDED IF AT ALL POSSIBLE.

STEP 11 — Remove protective coating from the fan shaft with kerosene and apply a coat of light oil to the clean shaft.

STEP 12 — Remove the bearing assembly opposite the sheave end of the fan shaft in the following manner:

- a. With an Allen wrench, loosen the set screws in thrust collar and slide the bearing off the shaft.
- b. Put bearing in a safe, clean place where it will not be dropped or mishandled.

LEAVE SECOND BEARING IN PLACE. THERE IS NO REASON TO REMOVE THIS BEARING.

STEP 13 — Loosen set screws on the fan wheel hub and remove fan shaft.

The fan section is now disassembled into its smallest parts. If desired, the fan wheels can be removed from their housings by unbolting the cut-off in the fan discharge openings and rolling the wheel out. The support angle frames can be removed at this time.

FILL AND BASIN SECTION (Refer to Drawing No. 7)

STEP 1 — Remove the front and back panels, air inlet screen and splash baffle by removing the hex head machine bolts.

STEP 2 — Remove the eliminator section by sliding it out. Store in a safe place to prevent damage to the blades.

STEP 3 — Remove the asbestos honeycomb fill a layer at a time.

STEP 4 — Unbolt and remove the turning vanes located under the fill support.

STEP 5 — Unbolt and remove the top stiffener frame at the top of the tower.

STEP 6 — Unbolt and remove the welded fill support frame.

AT THIS POINT THE TOWER STRUCTURE IS UNSTA-

BLE. USE CARE TO PREVENT DAMAGE TO THE CASING END PANELS.

STEP 7 — On models 6340 thru 6390 towers, remove the U-bolt support located in the middle of the large header pipe.

STEP 8 — Unbolt and remove the spray system assembly. Wire the rubber gaskets to the spray system or the end panels to prevent their becoming lost.

STEP 9 — Unbolt and remove casing panels.

STEP 10 — On models 6340 thru 6390, unbolt the center uprights from the basin gussets only and remove. *Do not disassemble the upright.* No disassembly of the water basin is required.

TOWER IS NOW DISASSEMBLED INTO ITS SMALLEST PARTS AND MAY BE MOVED TO THE REQUIRED LOCATION.

REASSEMBLY PROCEDURE

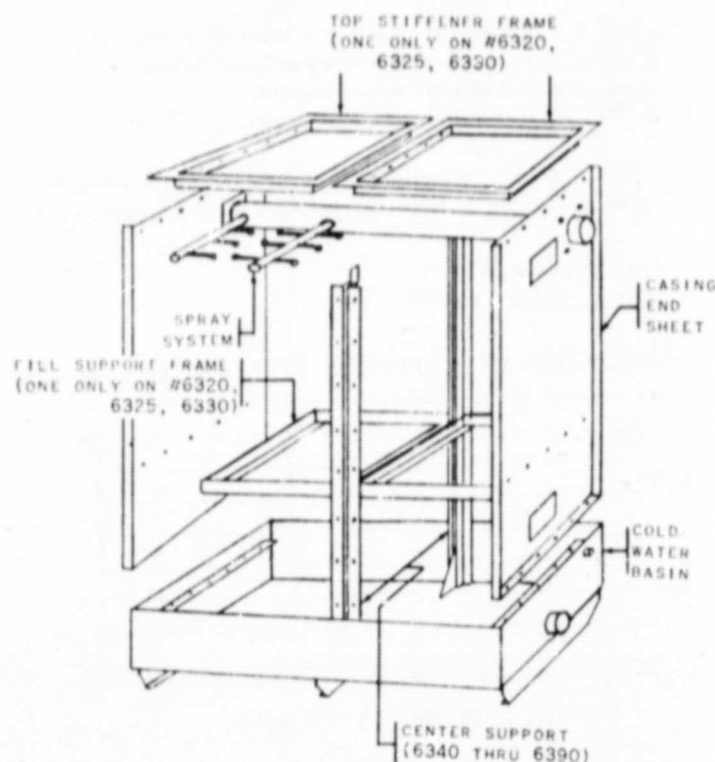
FILL AND BASIN SECTION (refer to Drawing No. 4)

STEP 1 — Set cold water basin in position.

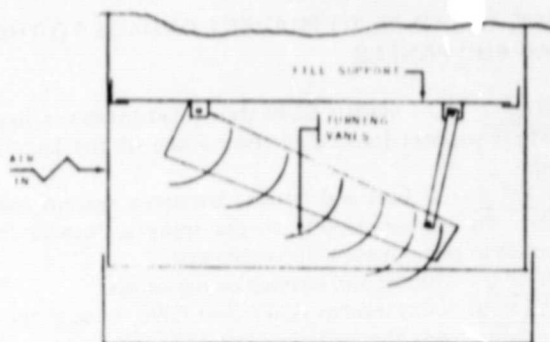
STEP 2 — Set the casing end sheets on the basin end support and fasten with round head bolts and lock washers.

STEP 3 — Position spray system. Install rubber gasket between pipe plate and casing end sheet. Bolt assembly in place with bolts and lock washers.

NOTE: Spray system must be level.



Drawing No. 4 — Casing Assembly (Steps 1 thru 7)



Drawing No. 5 - Turning Vane Installation

STEP 4 - Models 6340 thru 6390 only: Install the center vertical supports. Bolt through basin gusset plates with round head bolts and lock washers.

STEP 5 - Bolt fill support frame(s) to casing end sheets with round head bolts. *Use a rubber backed steel sealing washer under each bolt head.* On models 6340 thru 6390 only, bolt frames to center vertical supports.

STEP 6 - Bolt top stiffener frame in position with round head bolts and lock washers. On models 6340 thru 6390 only, bolt frames to center vertical support.

STEP 7 - On models 6340 thru 6390 only install U-bolt around the header pipe and fasten to the center vertical supports.

STEP 8 - Install turning vanes as shown on Drawing No. 5, using round head bolts and lock washers.

CAUTION: *The bottom edge of curved blades MUST point towards the air inlet.*

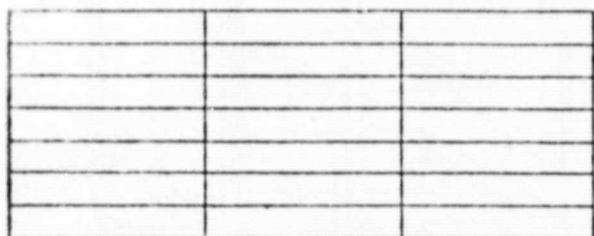
STEP 9 - Install fill panels one layer at a time. Do not force or compress panels. Install so length of panels is perpendicular to direction of inlet header.

STEP 10 - Install eliminator section(s).

IMPORTANT: *Eliminators must be installed correctly. Slide eliminator section into position on the support rails*

FILL INSTALLATION (Refer to Drawing No. 6)

ASBESTOS HONEYCOMB FILL PANELS



FILL SUPPORT FRAME

Drawing No. 6 - Fill Installation (Step 9)

above the spray system. When correctly installed the blade tabs will be visible as shown on Drawing No. 7. If blade tabs are not visible, rotate section 90°.

STEP 11 - Inspect the sponge rubber gaskets. Reglue or replace any loose or damaged gaskets.

STEP 12 - Check to see that the "S" strip is on the cold water basin edge. Open groove in strip is inside of basin.

STEP 13 - Install air inlet splash baffles by setting bottom edge of support in the "S" strip groove and swinging assembly into place. Do not bolt in place at this time.

STEP 14 - Line up air inlet screen with holes in splash baffle assembly and bolt both parts to the tower with hex head bolt and rubber backed seal washer.

STEP 15 - Set front and back casing panels in place and fasten with hex head bolts and rubber backed seal washer.

FILL AND BASIN REASSEMBLY IS NOW COMPLETE.

FAN SECTION

(Refer to Drawing No. 9)

NOTE: *Fan section may be assembled on or off the fill and basin section.*

STEP 1 - Bolt angle frames to fan housing with round head bolt, cut washer and lock washer. Roll fan wheel into housing and install fan cut-off sheet.

STEP 2 - Set the lower side sheets in position and bolt to fan housing frames with round head bolts and lock washers.

STEP 3 - Install motor support angle and motor support brace bolt to the fan housing frame as shown on Drawing No. 9 using serial number plate as location reference.

STEP 4 - Bolt top cover sheet to fan housing frames with round head bolts, cut washers and lock washers.

STEP 5 - Fan shaft with attached bearing is to be installed on the serial number plate end of the fan section.

On models 6320, 6325 and 6330: Slide the fan shaft through fan wheel hub until the attached bearing assembly is in line with the holes in the bearing support bar. *(Do not tighten fan hub set screws at this time.)*

On first models 6340, 6350 and 6360: Slide the fan shaft through fan wheel hub until the attached bearing assembly is in line with the holes in the bearing support bar. *Do not assemble to second fan or tighten fan hub set screws at this time.*

STEP 6 - Install second bearing on shaft. Leave set screws loose.

Use extreme care - do not force or hammer on bearing. Keep all parts clean and free from dirt. A light coat of oil on fan shaft will help installation.

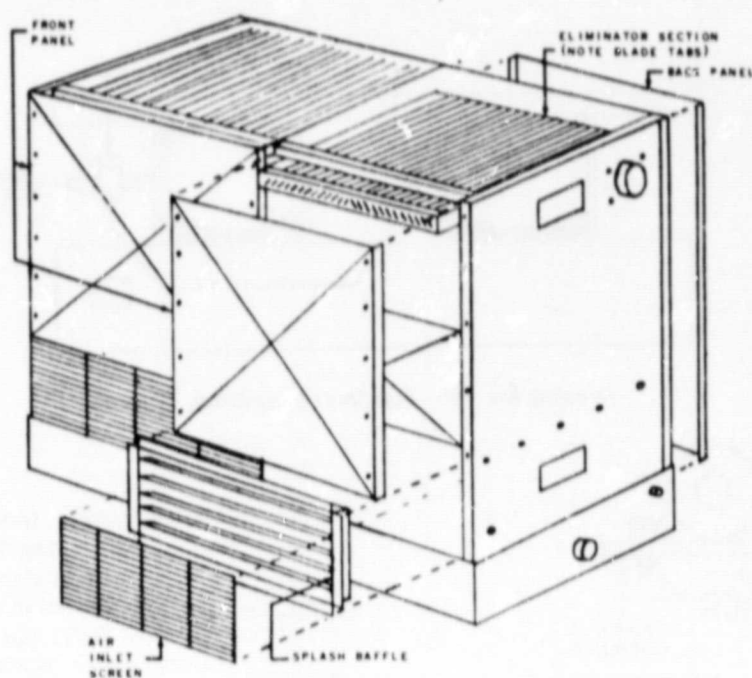
STEP 7 - On models 6340, 6350 and 6360: Push fan shaft through second fan wheel hub until end of shaft is flush with end of hub. *Do not tighten fan hub set screws.*

STEP 8 - Align fan shaft and fasten bearings to the support bar with bolts and self locking nuts.

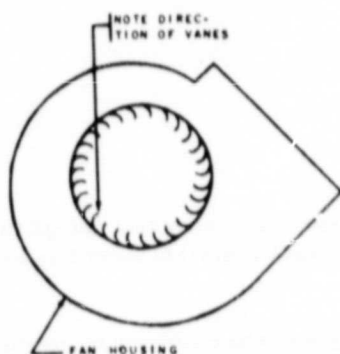
STEP 9 - Tighten bearing thrust collar set screws.

STEP 10 - Adjust fan wheel(s) until there is equal clear-

(continued page 7)



Drawing No. 7 - Fill and Basin Assembly



Drawing No. 8

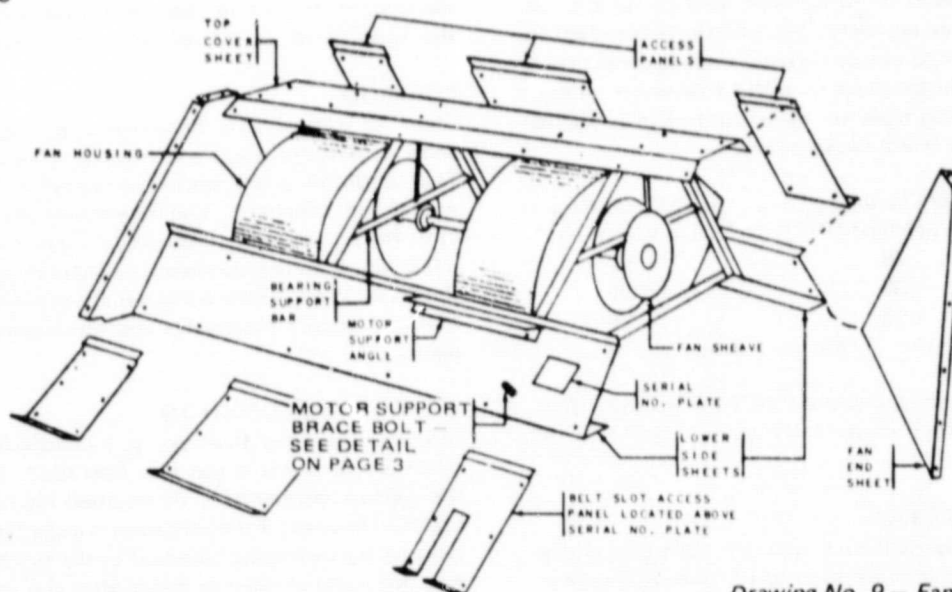
ance on both sides of the fan housing and tighten fan set screws.

STEP 11 - Connect oil lines to the bearing housings. Fill oil cups and oil lines with recommended lubricant. See page 9.

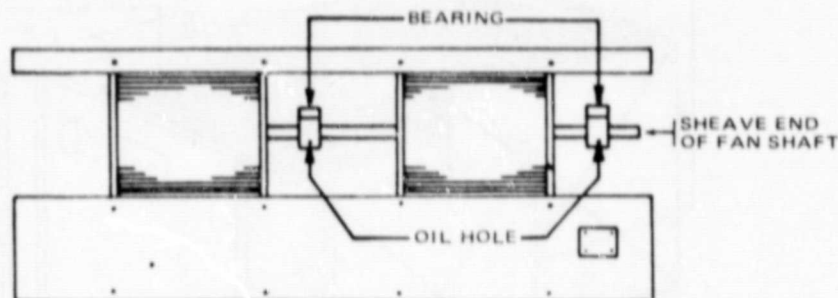
STEP 12 - Install fan sheave as follows:

- a. Place sheave without bushing on the fan shaft and push sheave back against the bearing.
- b. Install bushing on the shaft small end first and push until end of the shaft is flush with flanged end of the bushing.

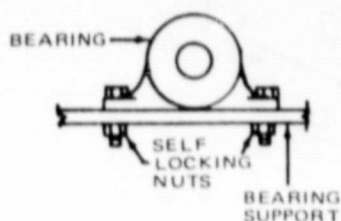
(continued top page 8)



Drawing No. 9 - Fan Section Assembly



Drawing No. 10 - Fan Shaft Installation (Step 5)



Drawing No. 11 - Bearing Installation

c. Pull sheave on bushing. Install cap screws through the large holes in the bushing flange and into the tapped holes in the sheave and tighten assembly.

STEP 13 - Install fan section end panels and fasten with round head machine bolts, cut washers and lock washers.

STEP 14 - Install access panels and fasten with hex head bolts, cut washers and lock washers.

WATER PROBLEMS AND TREATMENT

BLEED-OFF

Bleed-off is the continuous removal of a small portion of the water from the circulating system. The purpose of bleed-off is to prevent dissolved solids from concentrating to the point where they will form scale. As a guide, many waters can be allowed to concentrate two or three times without causing scale problems. The amount of bleed-off to hold concentrations to two or three depends upon the cooling range (hot water temperature minus cold water temperature). The following table shows amount of bleed-off required at three different cooling ranges.

Cooling Range °F.	% of Circulating Rate to Bleed-Off*	% of Circulating Rate to Bleed-Off**
5	.18	.38
10	.38	.78
15	.58	1.18

*Maintain 3 concentrations; **Maintain 2 concentrations

EXAMPLE: 80 gpm circulating rate, cooling range 10°F. To maintain 3 concentrations, the required bleed-off = $80 \times .0038 = .30$ gpm.

CHEMICAL TREATMENT

The quality of many municipal waters is such that chemical treatment for scale prevention or removal will not normally be required if adequate bleed-off is maintained. In areas where bleed-off alone is not sufficient to prevent ob-

jectionable scale or corrosion, use a simplified phosphate treatment as directed by the local supplier of water treating materials.

Algae and slime may occur and can be controlled by careful application of proper chemicals. Improper application of concentrated water treating chemicals may damage parts of the system. If scale or algae and slime accumulate, obtain the services of a competent water treating consultant.

FOAMING

Foaming occasionally becomes a problem with certain water conditions when a new tower is put into operation. The condition is not normally persistent for an extended period and foaming can be lessened by increasing bleed-off until the condition is improved. If increased bleed-off does not lessen foaming sufficiently, a foam depressant chemical should be used. These are generally available through local chemical supply companies and some water treating companies.

WATER DISCOLORATION

Discoloration, like foaming, is a condition that develops when a new tower is put into operation. It will not harm the normal components in an open recirculating cooling system. However, if discoloration is objectionable, it can be reduced by increasing bleed-off or the system may be emptied and refilled once or twice after the initial start-up of the tower. Commercial bleaching agents may be used but must be used with care as they may damage the system.

SEASONAL SHUTDOWN: INSTRUCTIONS

BASIN AND FRAME

Drain the tower basin and all exposed piping. Leave the basin drain open. Water may be left in basin if tower is located in a non-freezing area.

During shutdown, clean the tower and make any necessary repairs. Apply protective coating as required to all metal parts. Particular attention should be given to bearing supports.

MECHANICAL EQUIPMENT

V-BELTS

At shutdown, inspect V-belts and if worn excessively, replace before start-up.

SLEEVE BEARINGS, Oil Lubricated Type

Check oil level once each month and add oil if necessary. See next section for lubricating oil information. Rotate shaft by hand to assure all parts are coated with oil.

ELECTRIC MOTORS

Do not start motor without determining that there will be no interference with free rotation of the fan drive.

Motors are equipped with grease or oil lubricated bearings. Refer to motor manufacturer's recommendations for lubrication and maintenance instructions.

If shutdown period is longer than seasonal, contact the Marley sales office or representative in your area for additional information.

BEARING LUBRICATION

Fan bearings are lubricated at the factory. Original lubrication is adequate for approximately 1000 hours or two months of normal operation. *It is not necessary to add at more frequent intervals.*

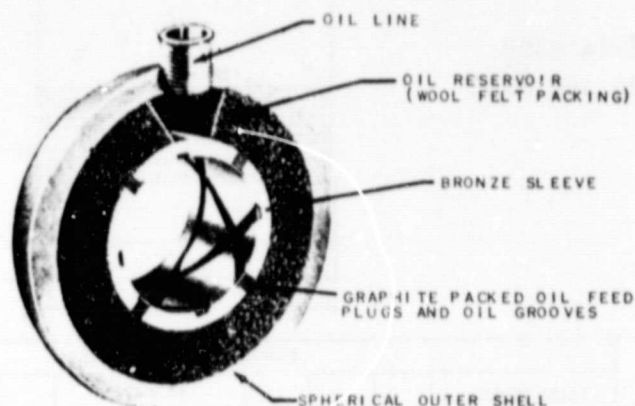
Fan bearings are constructed with an oil reservoir between the spherical outer shell and the bronze sleeve. The reservoir is packed with wool felt which absorbs oil and distributes it through feed plugs in the oil grooves. (See illustration.) Graphite filled grooves redistribute oil to the bearing surface.

Rate of oil flow through the bearings is controlled by density of wool and graphite packing. Variance in packing dens-

ity results in differences in the length of time required for oil cups to empty; time required may vary from a few days to several weeks or months.

If oil flow rate permits the oil cup to empty in one to two days:

1. Check oil line for leakage.
2. If oil line shows no leakage continue *recommended lubrication schedule*. It is not necessary that oil be visible in cup between fillings.



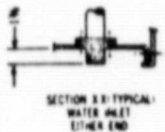
CROSS SECTION THROUGH BEARING

RECOMMENDED LUBRICANTS

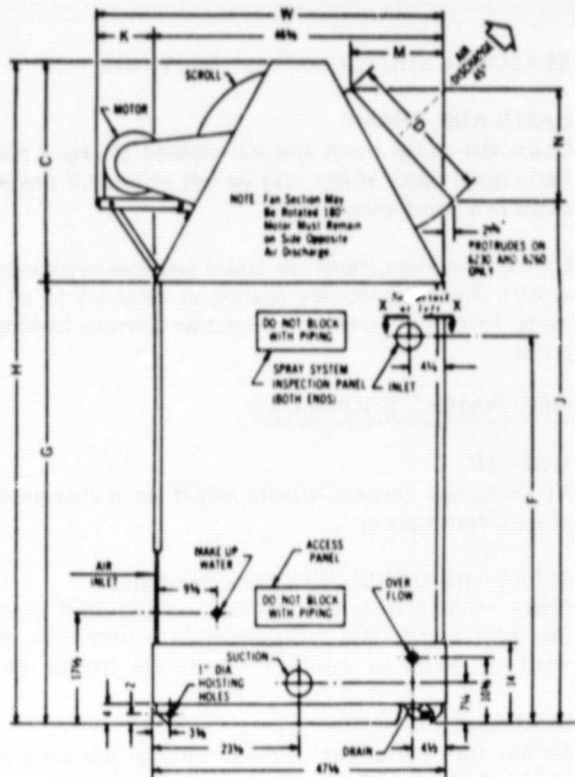
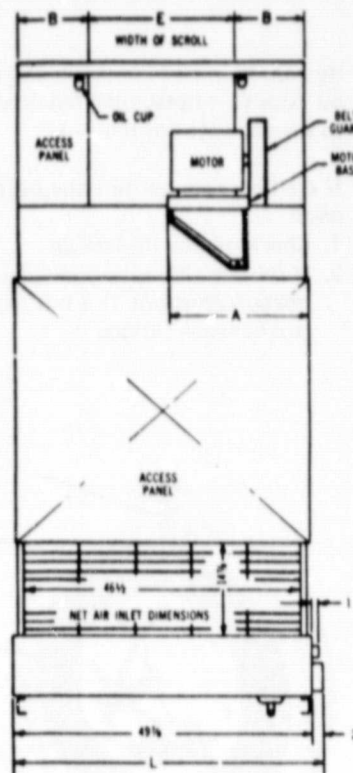
Recommended lubricants are industrial type mineral oils or automotive crankcase oils except those designated "Detergent," "Heavy Duty," or "Compounded." For given operating conditions use the following oils:

Summer or Indoor Operation
(40°F. to 110°F.) — SAE 50
Winter, Outdoor Operation
(0°F. to 40°F.) — SAE 10

When the tower is located outdoors and is operated during summer and winter seasons, it is recommended that the change from SAE 50 to SAE 10 oil be made during a period of temperature transition to insure the lighter oil has adequate time to flow from the oil cup to the bearing reservoir. If oil change is made in cold weather, remove and drain oil line before adding SAE 10 oil.



Models 6320,
6325 and 6330



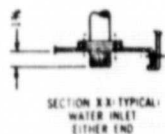
MODEL NO.	DIMENSIONS IN INCHES														CFM	NO. OF FANS	HP. ①	PIPE SIZES, INCHES					WEIGHTS	
	TOWER OVERALL			A	B	C	D	E	F	G	J	K	M	N				INLET	SUCTION	DRAIN	OVERFLOW	FLOAT VALVE	*SHIPPING (Less Motor) ②	OPERATING (Wet) ③
	INSTALLED																							
	W	L	H																					
6320	55¼	51⅞	98	25	14	31¼	24⅝	21	58¼	66¾	80¼	8⅝	18	17½	5875	1	1½	3m	4m	1½m	2m	½m	1278	1880
6325	55¼	51⅞	104	25	14	31¼	24⅝	21	64¼	72¾	86¼	8⅝	18	17½	6380	1	2	3m	4m	1½m	2m	½m	1358	2030
6330	57	51⅞	109	23⅜	12⅜	36¼	28¾	24¼	64¼	72¾	88	10½	17⅜	20⅞	8110	1	3	3m	4m	1½m	2m	½m	1424	2175
6340	55¼	98⅝	98	25	14	31¼	24⅝	21	58¼	66¾	80¼	8⅝	18	17½	11750	2	3	4m	4m	1½m	2m	½m	2278	3515
6350	55¼	98⅝	104	26	14	31¼	24⅝	21	64¼	72¾	86¼	8⅝	18	17½	13870	2	5	4m	4m	1½m	2m	½m	2382	3710
6360	57	98⅝	109	24⅜	12⅜	36¼	28¾	24¼	64¼	72¾	88	10½	17⅜	20⅞	16220	2	5	4m	4m	1½m	2m	½m	2541	3980

① Wet operating weights are based on 6 inches of water in tower basin.

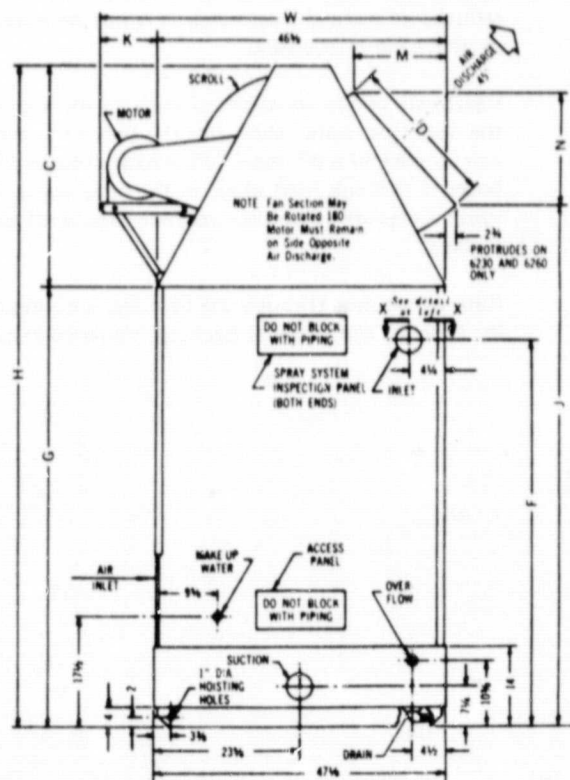
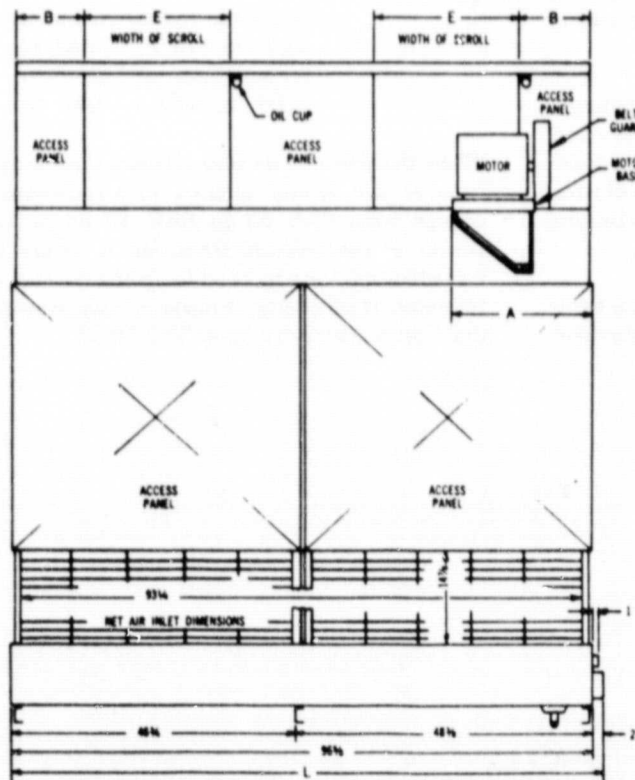
② Protected motors are furnished on these models.

③ Motor weights: Models 6320, 6325—75 lbs., Models 6330, 6340—110 lbs., Models 6350, 6360—122 lbs.,

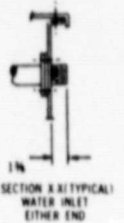
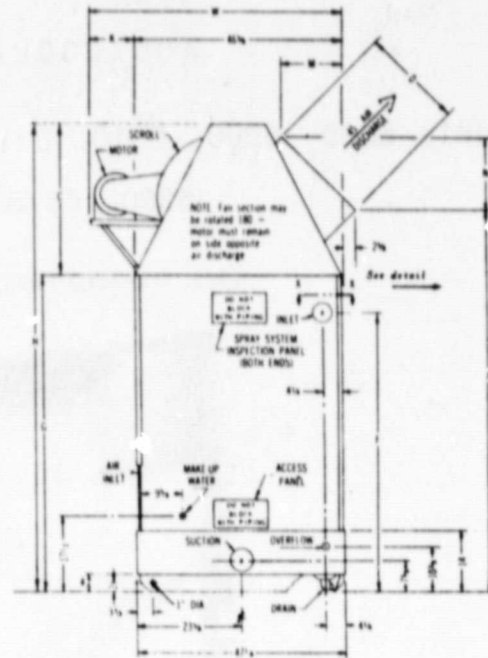
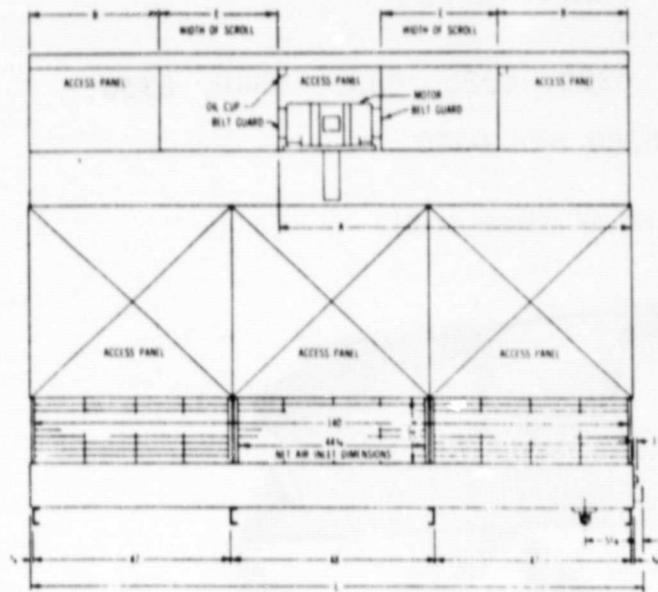
Pumping head is 18.0 feet for Models 6320 and 6340 and 18.5 feet for all other models in the table above. Pump head is measured from base of tower when circulating 3 gpm per ton at 95-85-75. For other conditions obtain pump head data from your Marley sales engineer.



Models 6340,
6350 and 6360



MODELS 6375, 6380, 6390



MODEL NO.	DIMENSIONS IN INCHES														CFM	NO. OF FANS	HP. ③	PIPE SIZES, INCHES					WEIGHTS	
	TOWER OVERALL			A	B	C	D	E	F	G	J	K	M	N				INLET	SUCTION	DRAIN	OVERFLOW	FLOAT VALVE	SHIPPING (Less Motor)	OPERATING (Wet)
	INSTALLED																							
	W	L	H																					
6375	57	145½	109	87	24½	36¼	28¾	24¼	64¼	72¾	88	10½	17¾	20½	19640	2	7½	4m	6m	1½m	3m	¾m	3550	6035
6380	57	145½	109	87	24½	36¼	28¾	24¼	64¼	72¾	88	10½	17¾	20½	21540	2	10	4m	6m	1½m	3m	¾m	3555	6060
6390	57	145½	109	87	24½	36¼	28¾	24¼	64¼	72¾	88	10½	17¾	20½	24660	2	15	4m	6m	1½m	3m	¾m	3560	6125

1. Wet operating weights are based on 6 inches of water in tower basin.

2. Protected motors are furnished on these models.

3. Motor weights L Model 6375 - 200 lbs., Model 6380 - 225 lbs., Model 6390 - 290 lbs.

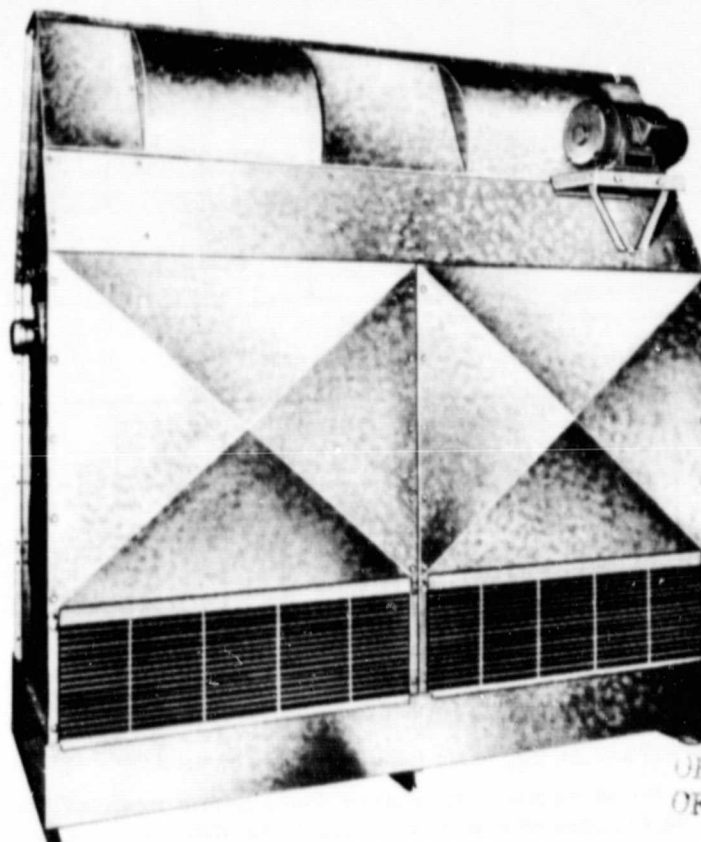
Pumping head is 18.5 feet for all models in table above. Pump head is measured from base of tower when circulating 3 gpm per ton at 95-85-78. For other conditions obtain pump head data from your Marley sales engineer.

AQUACOOLER PARTS LIST

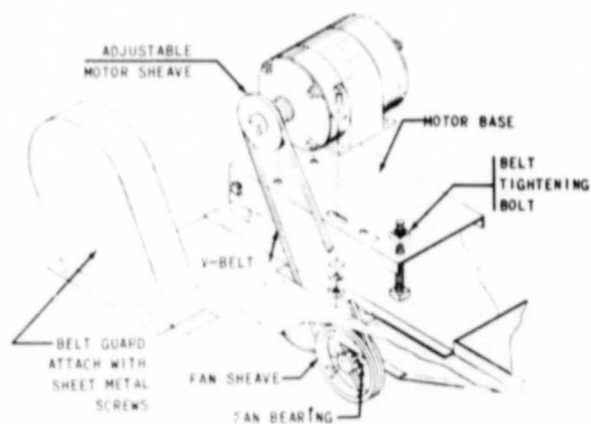
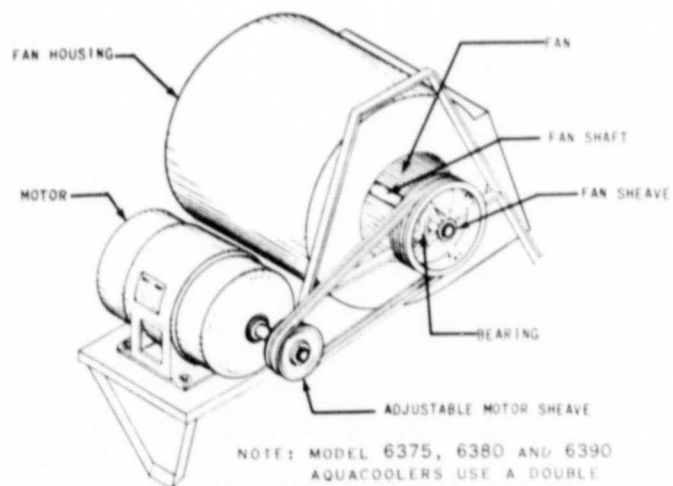
for

Models 6305, 6308, 6310, 6315, 6320, 6325, 6330, 6340, 6350,
6360, 6375, 6380 and 6390

(SEE ITEMIZED PARTS LIST ON REVERSE SIDE)



ORIGINAL PAGE IS
OF POOR QUALITY



IMPORTANT -- The SERIAL and MODEL NUMBERS of tower MUST be provided when ordering parts.

AQUACOOLER PARTS LIST

REF. NO.	DESCRIPTION OF PARTS	MODELS - Quantities Used										
		6305	6308	6310	6315	6320	6325	6330	6340	6350	6360	6375
1	MOTOR											
	1/2 Hp, 1725 RPM TE	1										
	1/2 Hp, 1725 RPM TEFC		1	1								
	1-1/2 Hp, 1750 RPM Protected				1	1						
	2 Hp, 1750 RPM Protected						1					
	3 Hp, 1750 RPM Protected							1	1			
	5 Hp, 1750 RPM Protected									1	1	
	7-1/2 Hp, 1750 RPM Protected, Double Extended Shaft											1
	10 Hp, 1750 RPM Protected, Double Extended Shaft											1
	15 Hp, 1750 RPM Protected, Double Extended Shaft											1
2	MOTOR SHEAVES											
	Browning 1VP 40, 5/8" Bore	1										
	Browning 1VP 50, 5/8" Bore		1									
	Browning 1VP 44, 5/8" Bore			1								
	Browning 1VP 56, 7/8" Bore				1	1	1					
	Browning 2VP 56, 1-1/8" Bore							1	1	1		
	Browning 2VP 62, 1-1/8" Bore										1	
	Browning 2VP 60A, 1-3/8" Bore											2
	Browning 2VP 75A, 1-3/8" Bore											2
3	FAN SHEAVES											
	Browning AK 69H, 1" Bore	1										
	Browning AK 79H, 1" Bore		1									
	Browning 1TB 80, 1-11/16" Bore			1								
	Browning 1TB 90, 1-11/16" Bore				1							
	Browning 1TB 136, O1 Bushing, 1-11/16" Bore					1	1					
	Browning 2TB 136, O1 Bushing, 1-11/16" Bore							1				
	Browning 2TB 136, O1 Bushing 2" Bore								1	1		
	Browning 2TB 184, O1 Bushing 2" Bore										1	
4	V-BELTS											
	Browning A 48	1										
	Browning A 53		1									
	Browning A 51			1								
	Browning B 55				1							
	Browning A 71					1						
	Browning B 71						1					
	Browning 2A 75 (Set of 2 matched belts)							1				
	Browning 2B 71 (Set of 2 matched belts)								1			
5	BEARINGS											
	Randall No. PB NB - G100C108 HE (1" Bore)	2	2									
	Randall No. PG NG - G111F400 HE (1-11/16" Bore)			2	2	2	2	2				
	Randall No. PJ NJ - G200K500 HE (2" Bore)								2	2	2	
	Randall No. QG MH - G111F408 HE (1-11/16" Bore)										4	4
												4
												4
												4
												4
6	FANS											
	Clarage Type 7/8 Centrifugal, 1" Bore	1										
	Clarage Type 1 Centrifugal, 1" Bore		1									
	Clarage Type 7/8 Centrifugal, 1-11/16" Bore			2								
	Clarage Type 1 Centrifugal, 1-11/16" Bore				2							
	Clarage Type 1-1/2 Centrifugal, 1-11/16" Bore					1	1					
	Clarage Type 1-3/4 Centrifugal, 1-11/16" Bore							1			2	2
	Clarage Type 1-1/2 Centrifugal, 2" Bore								2	2		2
	Clarage Type 1-3/4 Centrifugal, 2" Bore									2		
7	FAN SHAFTS											
	1" Dia. CRS 80842091107	1	1									
	1-11/16" Dia. CRS 80856091261			1	1							
	1-11/16" Dia. CRS 80856091180					1	1	1				
	2" Dia. CRS 80860091343								1	1	1	
	1-11/16" Dia. CRS 80856091213										2	2
8	FLOAT VALVES											
	3/8" Flapen	1	1	1	1							
	1/2" Flapen					1	1	1	1	1	1	
	3/4" Flapen											1

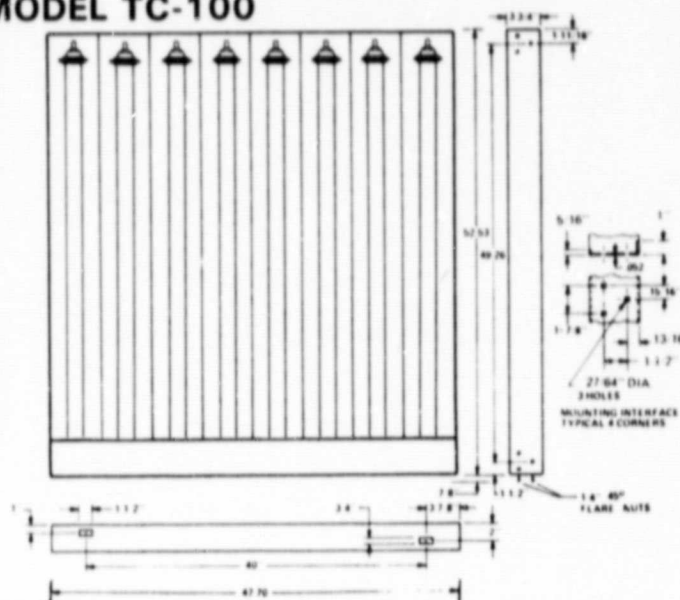
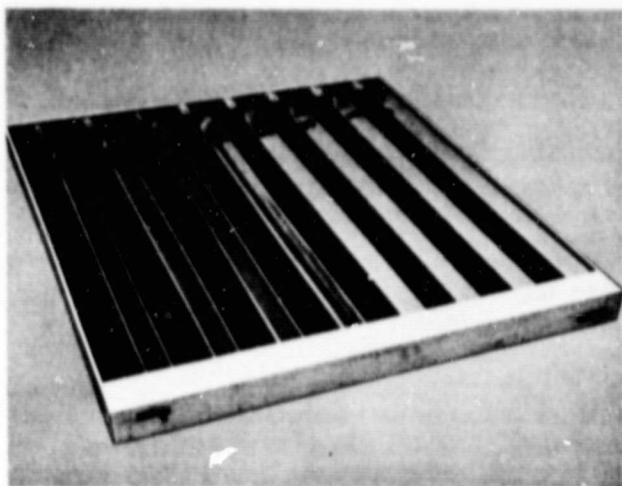
GENERAL ELECTRIC

VACUUM TUBE COLLECTOR RECOMMENDATION DATA SHEET
COLLECTOR, MODEL TC-100

APPENDIX D

Manufacturers Literature

General Electric Collectors

VACUUM TUBE SOLAR COLLECTOR SPECIFICATION DATA SHEET
SOLARTRON® MODEL TC-100

PHYSICAL WEIGHTS

	British	SI
Frame Only	35 lbs.	16 kg
Glass Installed		
Dry	57 lbs.	26 kg
Wet	59 lbs.	27 kg

COMPOSITION

Frame	18 Ga aluminized steel (51.6 mil)
Reflector	Alglas TM
Insulation	Fiberglass
Fluid Lines	1/4" type L copper
Glass Tubes	008 soda lime

CONNECTIONS

Hydraulic	Brass 1/4" 45° Flare Nut
Structural Attachments	Stainless Steel or aluminum

EQUIPMENT SIZING GUIDELINES

Heat exchanger area		
Heating	.17 ft ² /module	.016 m ² /module
Cooling & Heating	.35 ft ² /module	.033 m ² /module
Storage Volume		
Heating Only	15 gallons/ module	56.8 liters/ module
Cooling & Heating	22 gallons/ module	83.3 liters/ module

OPERATIONAL

	British	SI
Insulation	0 to 400 BTU/ft ² /hr	0 to 108 langleys
Fluid		
Operating Temperature	100 to 300°F	38 to 149°C
Composition	1. "Good" water with 35/50% Prestone II (1M)	

MODULE DESIGN CONDITIONS

Pressure Drop-Design	7.0 psi @ 180°F	48.2 kPa @ 82°C
Minimum	5.0 psi	34.5 kPa
Flow Rate	0.22 gpm @ 180°F	0.83 l/m @ 82°C
Wind Velocity (Max)	100 mph	161 km/hr
Ice Load (Max)	13 psf	63.5 kg/m ²
Snow Load (Max)	20 psf	97.6 kg/m ²
Combined Load (Max)	33 psf	161.1 kg/m ²
Minimum Array Pressure	45 psig	310 kPa

MODULE AREA

Gross (Frame)	17.4 ft ²	1.62/m ²
Net (Active)	14.8 ft ²	1.38/m ²

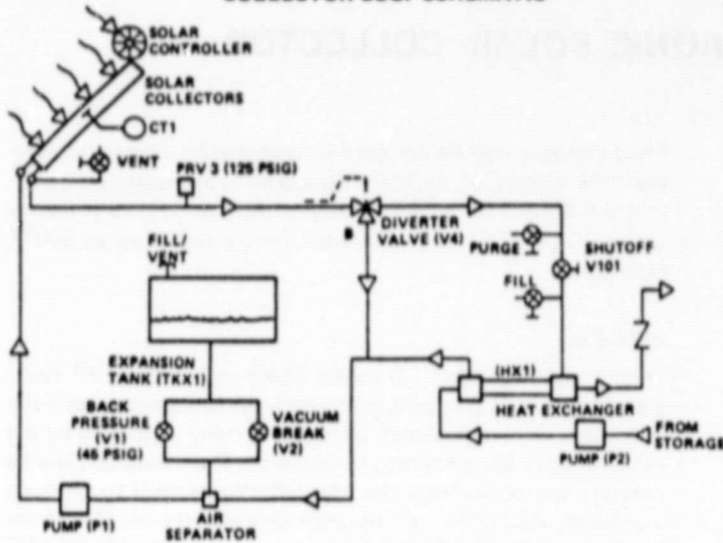


"Good" Quality Water:

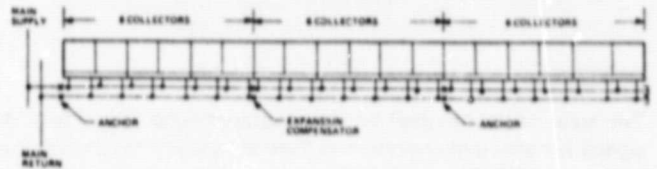
Chlorides	< 100 ppm
Sulfates	< 100 ppm
Bicarbonates	< 100 ppm
Total Hardness	< 250 ppm

TYPICAL DESIGN CONSIDERATION

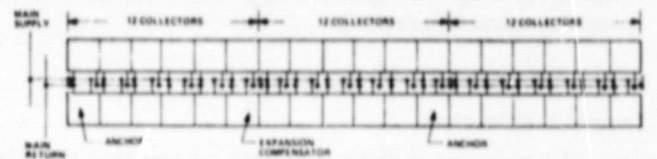
COLLECTOR LOOP SCHEMATIC



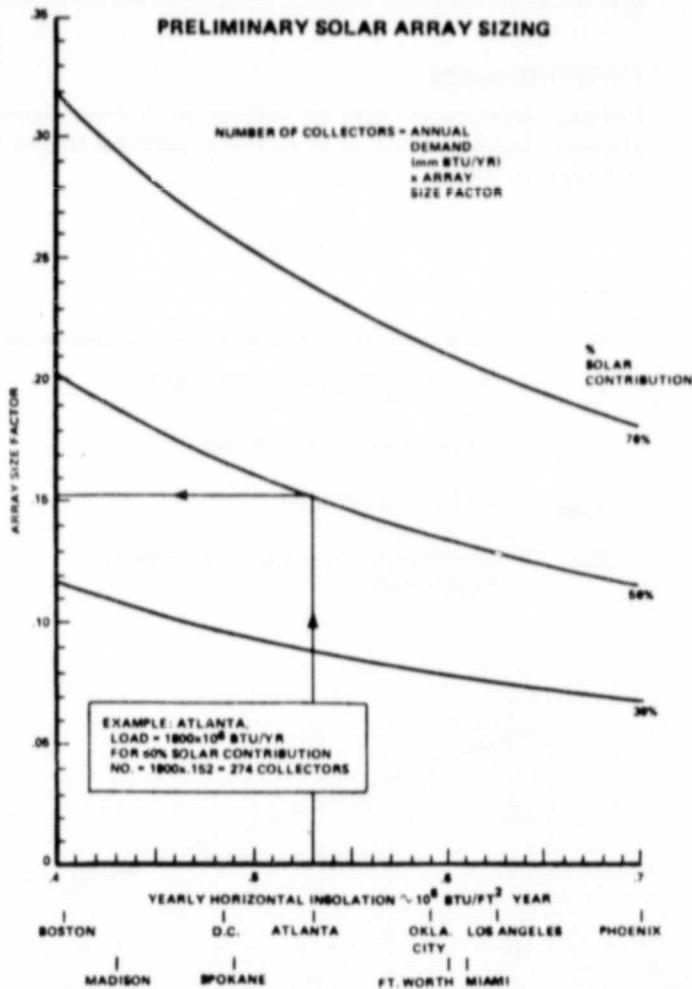
SINGLE ROW PLUMBING CONFIGURATION



DUAL ROW PLUMBING CONFIGURATION



PRELIMINARY SOLAR ARRAY SIZING



MODULE PRESSURE DROP (@ 180°F)

FLUID	Δ P (PSI)
100% water	5.3
35% glycol/water	6.2
50% glycol/water	7.0

HEADER

TUBE SIZE	TYPE COPPER	MAXIMUM NUMBER OF PANELS/ROW
3/4"	L	18
1"	L	36

OPTIONAL ACCESSORY HARDWARE

HEADER KIT
MOUNTING KIT
SOLAR CONTROLLER
LEXAN OR ACRYLIC WINDOW

For Further Information Contact:
Manager, Solar Heating and Cooling Marketing
General Electric Company,
P.O. Box 13601,
Philadelphia, PA. 19101
Phone - (215) 962-2112/2113

GENERAL  ELECTRIC

SPECIFICATION

EVACUATED TUBE HYDRONIC SOLAR COLLECTOR

GENERAL

The solar collector shall be an evacuated tube liquid type designed for efficient operation at fluid temperatures ranging from 100 to 300°F (66 to 149°C). The collector module shall be furnished with all the necessary components, excluding support attachments, ready for field attachment to support and piping systems. Specifications and requirements stated herein shall not supersede applicable Federal, State, or Local Codes and Regulations.

SOLAR COLLECTOR MODULE

General Construction

The solar collector shall be composed of standard manufactured modules which are designed for simple attachment to the support structure and piping system. The modular unit shall have a gross dimensions of approximately 4 feet by 4 feet (1.2 by 1.2 meters) with an active-to-gross area ratio greater than 0.85. The active (effective) area, as defined by the manufacturer, is the planar area onto which incident energy is directed to the absorber surface (s). The gross operating weight of the solar collector shall not exceed 4.0 pounds per square foot (19.5 kg/m²) of gross area. The collector assembly shall be capable of withstanding wind velocities of up to 100 mph (161 km/hr) with an ice and snow load of 20 lb/ft² (97 kg/m²) without structural damage.

Glass Tubes

The module shall consist of evacuated glass tubes which are composed of two concentric glass tubes separated by a vacuum of less than 10⁻⁴ Torr. The glass construction shall contain the vacuum without the usage of mechanical seals. The vacuum shall be maintained for the life of the tube at temperatures up to 650°F (343°C) with an active getter.

The outer radial surface of the inner glass tube shall have a coating with an average hemispherical emittance less than 0.05 at 212°F (100°C) and an absorptivity greater than 0.85. The solar absorptance of the glass shall be greater than 87 percent of the visible light spectrum.

Long term degradation of coating and glass properties shall have a combined effect of less than 10 percent of the total absorbed energy.

Fluid Passages

The collector unit shall be suitable for use with water or a mixture of water and anti-freeze solution (up to 50 percent by volume) as the heat transfer fluid.

Fluid passages shall not be restricted, when the specified fluid quality is maintained, to the point that collection efficiency (as a function of fluid flow) is decreased by more than 5 percent over the design life of the collector.

Fluid passages shall be designed to withstand, without degradation, the effects of no fluid flow and high insolation condition. Fluid passages shall be designed for operational pressures up to 80 psi (551 kPa) and fluid temperatures up to 300°F (149°C).

Insulation

There shall be at least 1.5 inches (3.80 cm) of 3 lb/ft³ fiberglass (48 kg/m³) or equivalent insulation surrounding all fluid-carrying components which are not thermally protected by the vacuum from the ambient environment. The insulation will be properly protected from the ambient environment to preclude significant insulation performance degradation resulting from ambient conditions. Fluid temperatures up to 650°F (343°C) shall not affect the performance or integrity of the insulation.

PERFORMANCE

Collector performance shall be defined by its instantaneous efficiency based on active collector area in graphical (Figure 1) and equation form as

$$\eta = A - B\psi$$

where

η = instantaneous collection efficiency (active area)

ψ = $(T_{col} - T_{amb}) / Q_i$ °F-hr-ft²/BTU

T_{col} = average collector temperature, °F

T_{amb} = ambient temperature, °F

Q_i = insolation on the plane of the collector
BTU/hr-ft²)

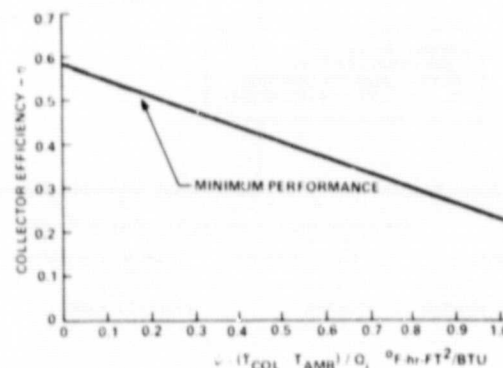


Figure 1. Instantaneous Collector Efficiency

The constants A and B are obtained by placing a least squared straight line through the data points located between $\psi = 0.0$ and $\psi = 1.0$. Certified test data from a recognized independent testing agency, along with manufacturer's test data, shall be identified on Figure 1 and utilized to define the constants A and B. Collector efficiency shall be determined in accordance with ASHRAE 93-77 test procedures.

The solar collector shall have an efficiency plot which is greater than the minimum performance line of Figure 1. The constant A shall be greater than 0.58 and B shall be less than $0.37 \text{ BTU/hr-ft}^2\text{-}^\circ\text{F}$.

QUALITY ASSURANCE

Manufacturer

The manufacturer of the solar energy collector shall be a recognized producer of said equipment and shall submit documentation demonstrating a high capability in design engineering, testing, fabrication, installation and maintenance of equipment the same as or similar to that called for on the drawings and in the specification(s).

All Other

All materials, assemblies, coatings, thermal bond connection, fluid connections, vacuum seals, structural members and hous-

ing configurations shall be of the highest quality and shall fully meet those standards called for and required in the "Interim Performance Criteria for Solar Heating and Cooling Systems in Commercial Buildings" (NBSIR 76-1187-1976). Any change and/or deviation from these criteria must be fully clarified. Standards and work of a higher quality than in the above cited, called for in these specifications and/or on the drawings, shall be met by the manufacturer.

OPERATIONAL DOCUMENTS

The manufacturer shall provide, within one (1) week of collector delivery, installation documentation for the collector. These manuals shall describe preventive maintenance, general maintenance, fluid quality control and replacement requirements and material replacement and control instructions.

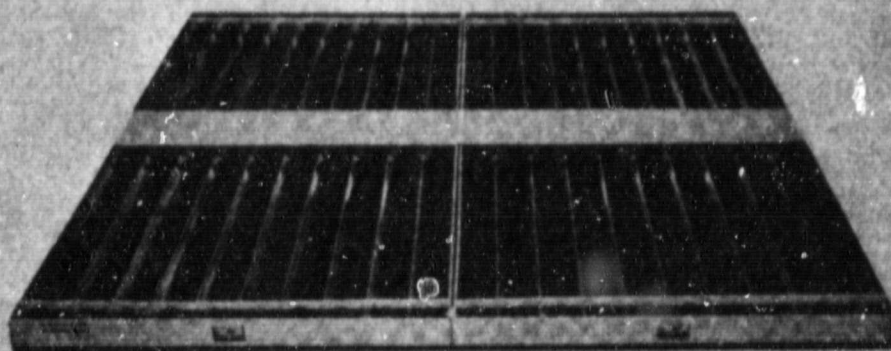
WARRANTY

The manufacturer shall warrant that at time of delivery, the solar collector will be free from defects in material and manufacture and will be of good quality and workmanship. This warranty shall provide for the replacement or repair, at the manufacturer's election, of the collector or parts thereof, provided that written notice of the defect shall be given to the manufacturer within one (1) year after collector delivery.

DOCUMENT NO. 78SDS4214B
AUGUST 1978

SOLARTRON® TC-100 VACUUM TUBE SOLAR COLLECTOR

COMMERCIAL AND INDUSTRIAL INSTALLATION MANUAL



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ADVANCED ENERGY PROGRAMS
P.O. BOX 13601
PHILADELPHIA, PA 19101

The various configurations included in this brochure are included for illustration of several typical solar collector system applications and are not intended as constructional information. Although reasonable care has been taken in their preparation to insure their technical correctness, no responsibility is assumed by the General Electric Company for any consequences of their use.

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1. INTRODUCTION

This document has been prepared to provide ARCHITECTS, CONSULTANTS, INSTALLING CONTRACTORS and ENGINEERS the basic data required to integrate a TC-100 vacuum tube solar array into a building design and to provide the mechanical contractor with the detail to install and check out the subsystem. Instructions for approximate sizing of a TC-100 array, component sizing and estimating system performance have been described in General Electric Document No. 78SDS4215B - Solartron[®], Vacuum Tube Solar Collector "Commercial and Industrial Application Guide."

Should you have questions regarding this material, or should you require additional information, contact:

Manager, Solar Heating and Cooling Marketing
General Electric Company
P.O. Box 13601
Philadelphia, PA 19101

Phone: (215) 962-2112/3

2. GENERAL DESCRIPTION

2.1 PHYSICAL CHARACTERISTICS

The General Electric Solartron TC-100 solar collector module (Figure 2-1) consists of eight glass vacuum tubes nested in a cusp-like reflector. The collector is designed to be mounted with the vacuum tube axis oriented up and down, with provisions for simple four-corner mounting. Two flare fittings connect each collector to the supply and return headers.

A collector module has an installed weight of approximately 57 pounds, or about 3.3 pounds per square foot. The collectors are installed without the glass vacuum tubes, and each module without the tubes weighs about 35 pounds, providing ease in handling. The TC-100 module collector is designed for an environmental loading (combined wind, ice, and snow) of 33 pounds per square foot when installed.

2.2 COLLECTOR COMPONENTS

The collector module consists of:

1. An aluminized steel frame
2. An Alglas[™] cusp-like reflector
3. Copper finned-tube loops to transport the working fluid
4. Glass vacuum tubes with propylene grommets and stainless steel spring clips.

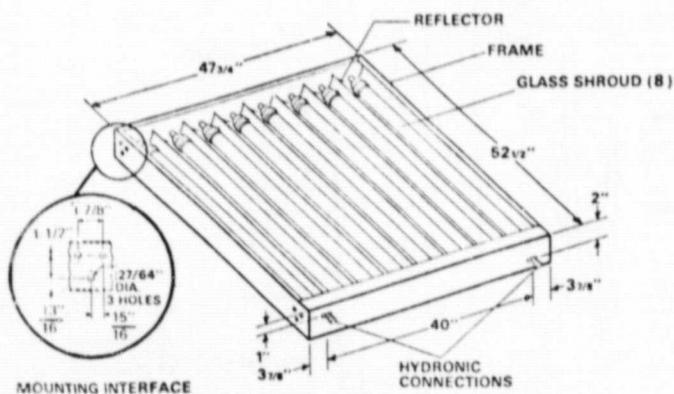


Figure 2-1. GE TC-100 Collector Module

The copper tubing between vacuum tubes is pre-insulated. The collector modules are completely assembled except for the glass vacuum tubes which are shipped separately. The modules are shipped with protective plastic covers over the copper finned-tubes. These plastic covers remain in place until the system is checked out at which time, the plastic covers are replaced with the glass vacuum tubes.

The glass vacuum tube and the finned-tube are shown in cross section in Figure 2-2. The glass vacuum tube consists of two glass cylinders joined to form a large "Thermos[™] bottle". The outer cylinder serves as the window, and the inner cylinder, which is selectively coated on the outer surface, acts as the absorber. The space between the two glass cylinders is evacuated. The energy absorbed is transferred through the inner glass tube and into a conforming cylindrical copper fin. The thermal energy is then conducted along the fin and into the fluid passing through the U-tube. This design eliminates glass-to-metal seals, eliminates impact of potential glass breakage on operational continuity, reduces thermal inertia, and eliminates thermal expansion differentials between metal and glass components. The 1/4 inch copper tubing which contains the working fluid terminates with 45-degree flare nuts for mechanical attachment to headers.

2.3 COLLECTOR FLUID

The recommended non-freezing working fluid is a mixture of 35 to 50 percent (by volume) Prestone II[™] ethylene glycol

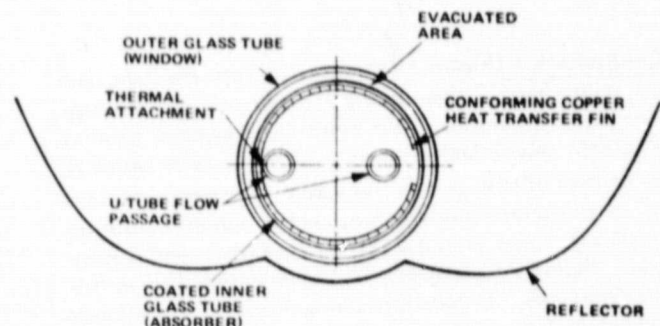


Figure 2-2. Cross-Section of Active Collector Elements

with distilled, deionized, or demineralized water,¹ which offers freeze protection to -4°F and -34°F , respectively. Operating temperatures should be limited to 300°F in order to prevent decomposition of the ethylene glycol.

¹Note: Water containing no more than the following is satisfactory:

chlorides	100 ppm
sulfates	100 ppm
bi carbonates	100 ppm
total hardness	250 ppm

2.4 OPTIONAL COLLECTOR ACCESSORIES

In addition to TC-100 vacuum tube solar collectors, General Electric offers several optional solar system accessory kits that have been engineered to facilitate collector installation and to contribute to the operational efficiency and reliability of the system.

Mounting Bracket Kits (Figures 3-3, 3-4 and 3-5) for either sloping surface, flat-roof or space frame applications are available. Direct mounting bracket kits (Figure 3-3) include T-brackets which lock the collector to commercially-available UNISTRUT® channels which are attached to the roof or other substructure. "Internal" brackets utilize pins while "external" brackets are bolted. The strut mounting option (Figure 3-4) offers a standard top and bottom bracket design for use with contractor-supplied transition struts. Space frame bracket kits (Figure 3-5) provide a standard L bracket with a 3/8 inch threaded U-clamp for 3" diameter tubes. All three kit options include the required nuts, bolts and washers.

Header Kits (Figures 5-4 and 5-9) are available for both single and dual collector configurations. Header kits include prefabricated header pipes with the appropriate hydraulic fittings, alignment/anchor brackets and clamps, fiberglass insulation, aluminum steel covers, joint and fastening hardware.

Collector Window Kits (Figure 2-3) are recommended ONLY for areas of extreme vandalism or for regions having incidences of large hail. The simply mounted collector window kit is offered either in UV-stabilized Lexan® or acrylic. Appropriate attachment hardware is included.

Solar Controller Kit (Figure 2-4) contains electronic logic and a silicon photo sensor that digitally integrates solar energy levels for system control. The controller operates from a 24 VAC 60 Hz source and outputs a 24 VAC signal which is used for control of loop pumps and valves. The controller also includes an overtemperature sensor used to inhibit operation of the collector loop pump(s) during abnormal temperature conditions. Figure 2-5 presents a simplified wiring diagram for the solar controller. Installation and application instructions are provided in General Electric Document No. 79SDS4231. The controller kit includes all mounting hardware and is mounted directly to a collector.

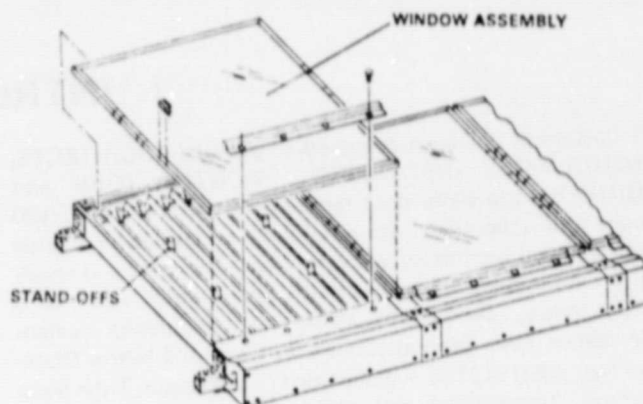


Figure 2-3. Collector Window Kit

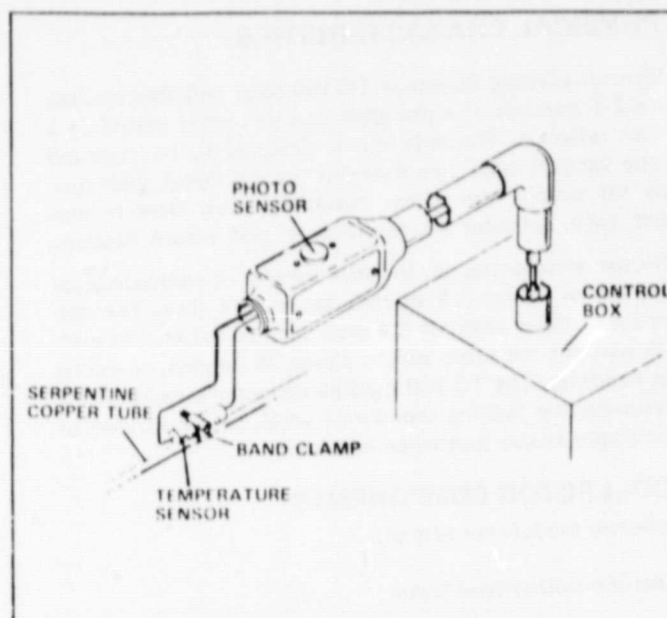


Figure 2-4. Solar Controller Kit

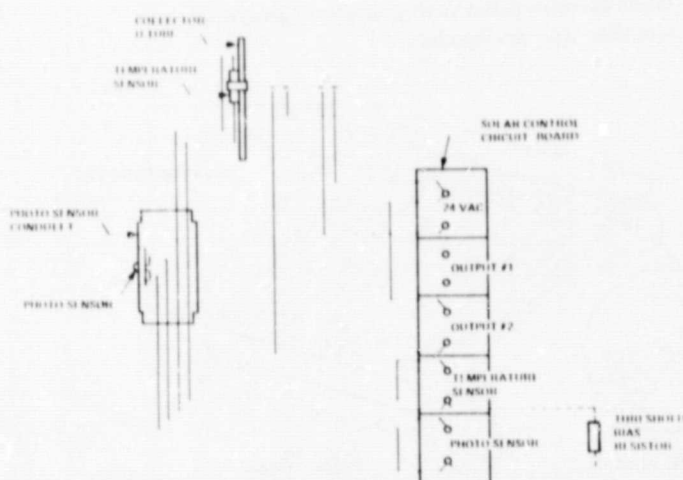


Figure 2-5. Solar Controller Wiring Diagram

3. COLLECTOR INSTALLATION

3.1 INSTALLATION SUMMARY

A summary of the installation procedure follows. The discussion herein includes GE optional accessories, but similar steps are recommended for field-procured accessories. Roof, ground, or space-frame mounting are all potential methods of installation, depending upon structural considerations, aesthetics and cost. The collectors may be arranged in individual rows (Figure 3-1) or in a dual row (Figure 3-2) utilizing common headers.

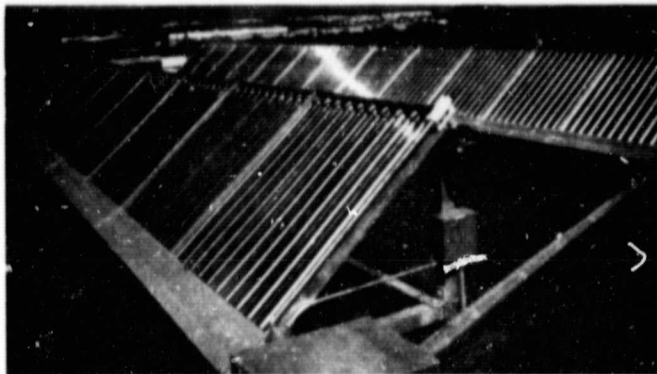


Figure 3-1. Single-Mounted Collector

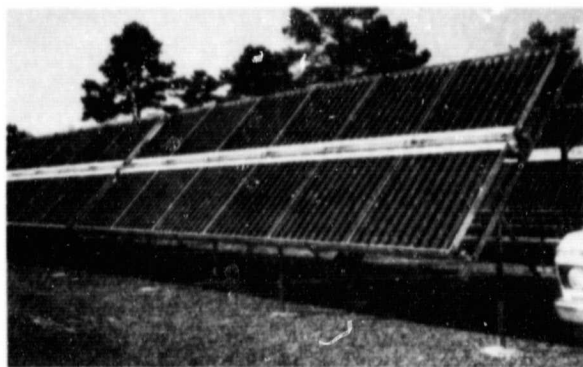


Figure 3-2. Dual-Mounted Collectors

Upon completion of the collector supporting structure, the collectors are mounted without the vacuum tubes (Section 3.4). The header tubes are then attached to the collectors and brazed together (Section 4.2). A leak check follows (Section 4.3). Operation of the balance of the solar system, including the controls is verified. The vacuum tubes are then installed (Section 5.1), followed by high-temperature cycling and checkout (Section 5.2). The piping is insulated and covered (Section 5.3), and the system is operational.

3.2 MOUNTING TECHNIQUES

There are many acceptable techniques for mounting solar collectors. The method selected must consider structural, architectural, cost and schedule constraints. As a guide for

collector mountings, two general techniques of many suitable for simple four-corner mounting are presented:

1. Direct mounting (Figure 3-3).
2. Strut mounting (Figure 3-4).

Specific requirements may warrant variations or a combination of the three.

A collector mounting technique that utilizes a UNISTRUT channel attachment (Figure 3-3) provides a simple, quick installation and will also allow flexibility in the lateral positioning of the mounting brackets. By avoiding hard-mounting of individual collector support brackets, installation time can be reduced significantly in the alignment and attachment of brackets and collectors. Installation time can be further reduced by using the internal mounting brackets offered in the General Electric mounting kits which use pins rather than nuts and bolts for slide-on interconnection of adjacent collector panels.

In a strut-mounted installation (Figure 3-4), hard mounting of individual collector support brackets is required to provide rigid support. Strut mounting will be somewhat more time consuming than a direct mounting in terms of both alignment and attachment. Cross-bracing may be required for lateral support.

3.3 LAYOUT AND SPACING

The initial step in collector installation is a layout of the array pattern. Since the collector attachment points are fixed at the four corners, spacing between UNISTRUTS must be closely controlled. This will facilitate installation, assure dimensional integrity of the array and preclude extraneous stresses on the collectors. Spacing between rows is less critical.

Typical spacing for UNISTRUT installations is shown in Figure 3-5 for single-mounted collectors and Figure 3-6 for dual-mounted collectors. The distance between adjacent rows is a nominal value to allow access. For a more compact collector array, the separation may be reduced, but provisions for a sliding ladder or working platform should be implemented to facilitate installation and potential maintenance. Lateral spacing between collectors is nominally 1/4 inch to accommodate a 3/16-inch thick T-bracket and a 1/16 inch header tube support bracket. In a dual row configuration, mounting of tube support brackets are alternated between the top and bottom collectors to maintain array symmetry and proper fitting of the collector tubing to the headers.

Typical spacing of bottom brackets for a strut-mounted installation is shown in Figure 3-7. The separation between the front and back brackets is flexible, but $49\frac{1}{4}$ " divided by the cosine of the collector tilt angle is most appealing.

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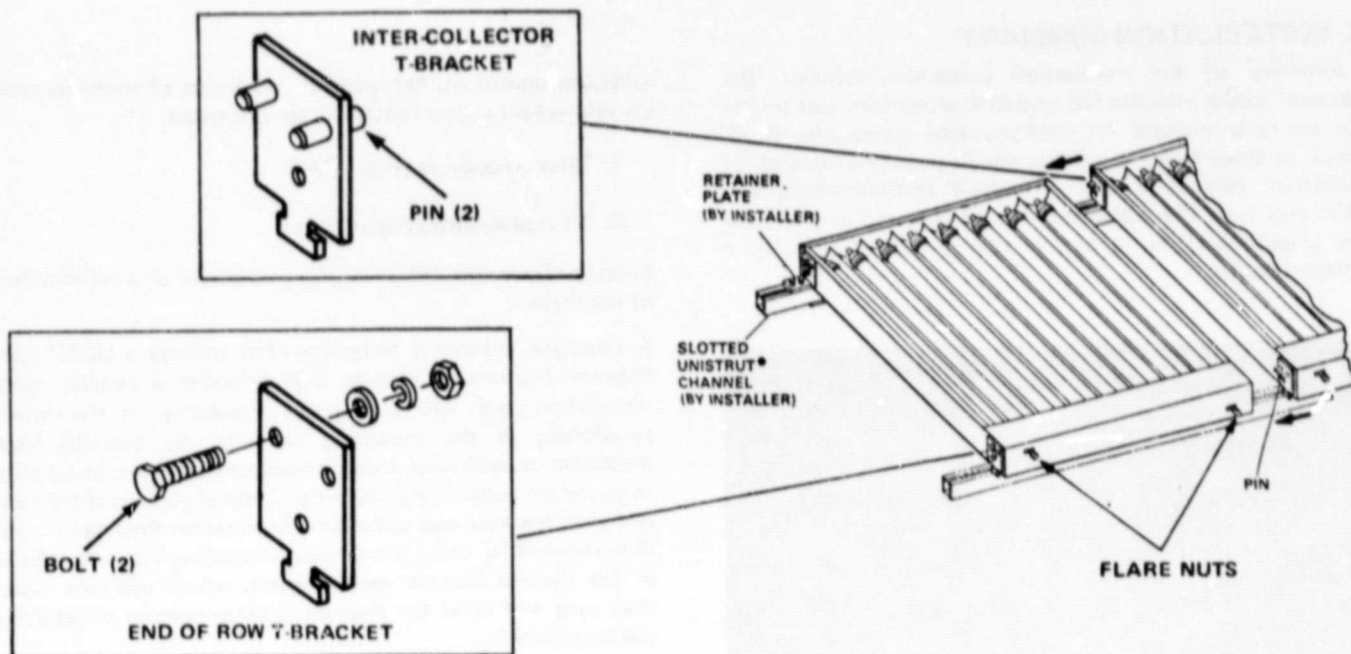


Figure 3-3. Direct Mounting Kits

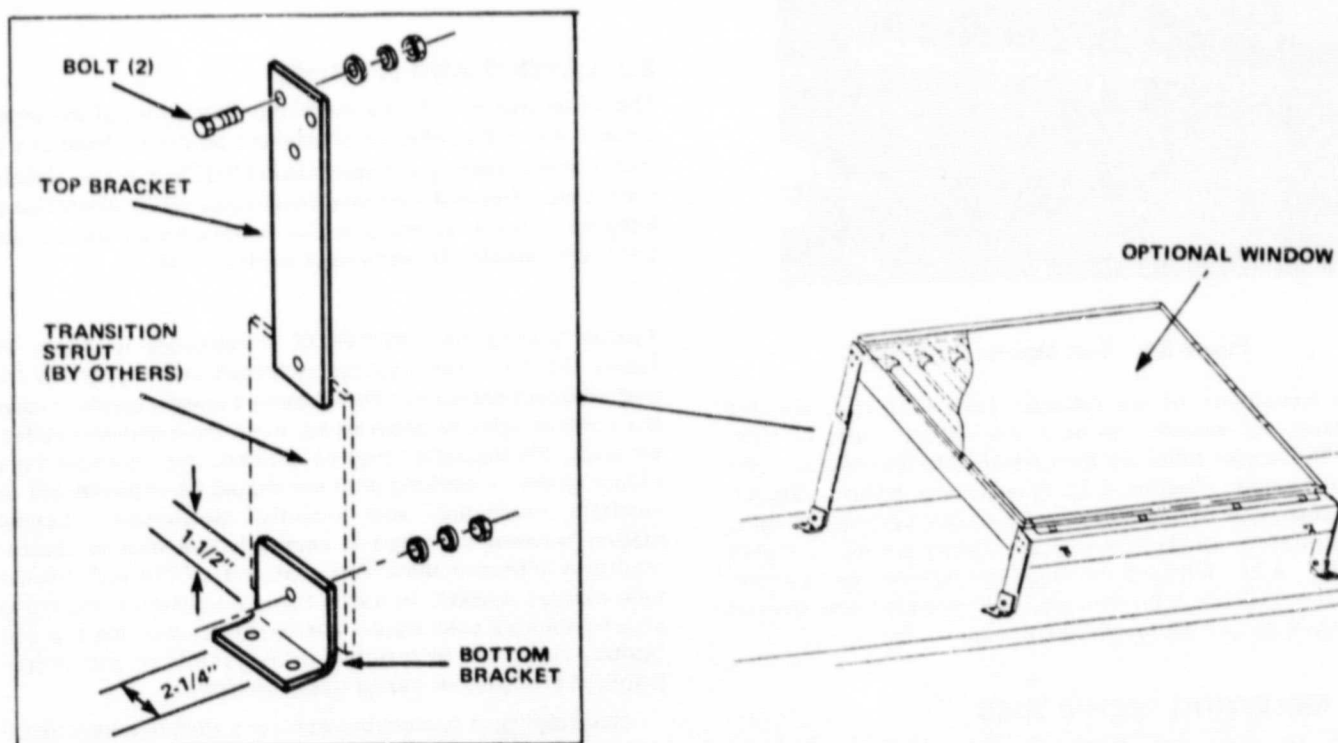


Figure 3-4. Strut Mounting Kit

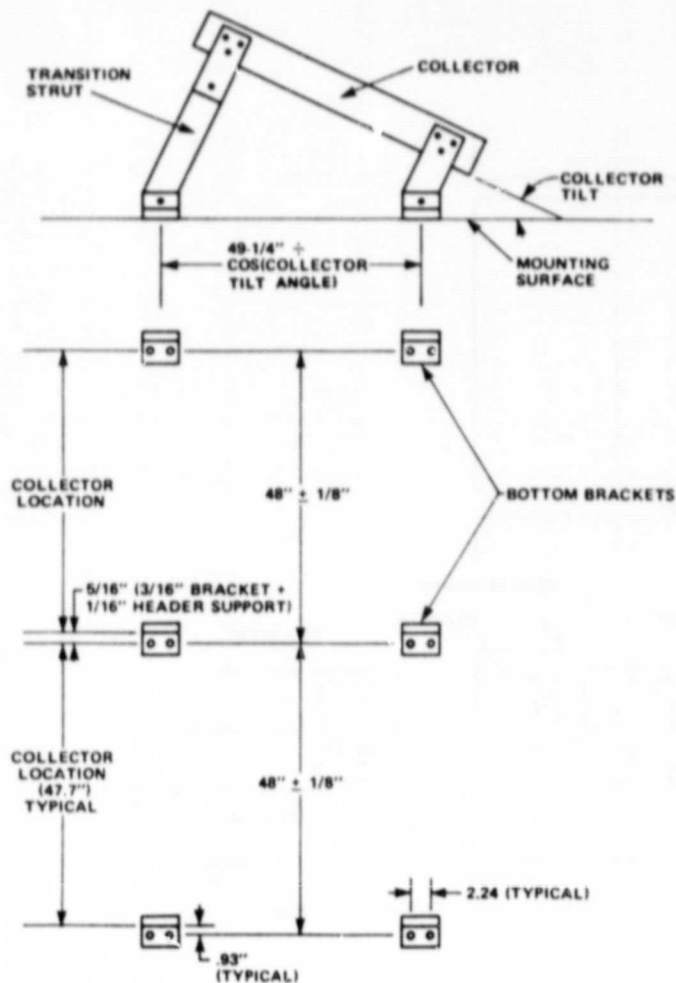


Figure 3-7. Bottom Bracket Spacing for Strut Mounting

3.4 INSTALLATION PROCEDURES

Note:

If the GE solar controller (Figure 2-4) is used, install an adapter bracket during the installation of the collectors preferably at the end of the row for convenience of accessibility in installation, wiring and maintenance. Mount controller in a position where it will not be shaded at any time.

Direct Mounting Collectors

Install UNISTRUTS with spacing shown in Figure 3-5 or 3-6 and attach to the roof, (Figure 3-8), or substructure. For roof mounting, include 1/4" neoprene-type spacer under the UNISTRUT at each attachment point. For dual mounted collectors, use P5500 series UNISTRUT or P1000 series with 1/4" spacers at the attachment points. Single- and dual-mounted collector installation instructions are described in the following sections. Use the instructions that apply to your configuration.



Figure 3-8. Attach UNISTRUT to Roof

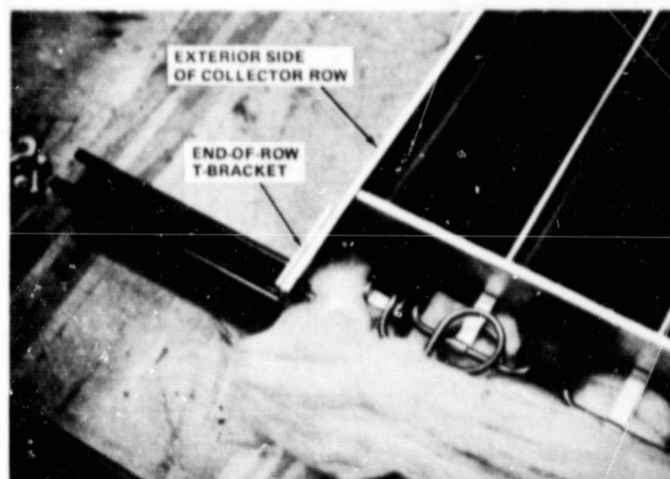


Figure 3-9. Bolted Lower T-Bracket

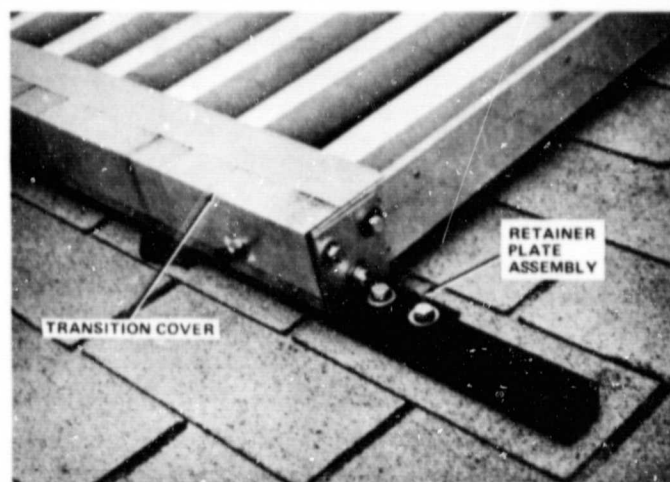


Figure 3-10. Place Collector on UNISTRUT

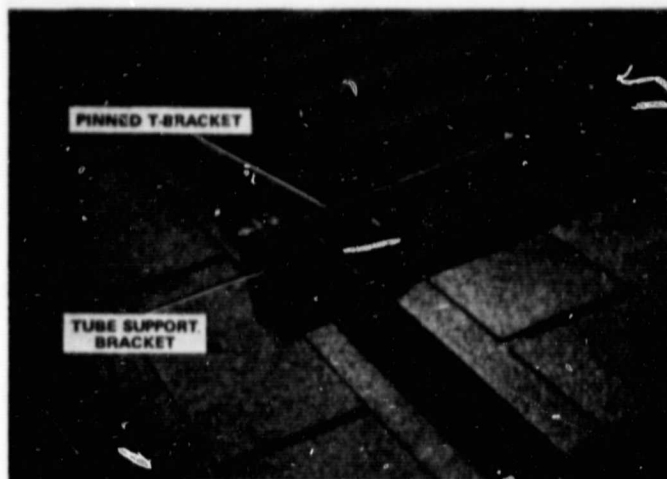


Figure 3-11. Internal Collectors are Fastened by Pinned T-Brackets

Note:

UNISTRUT channels (or equivalent) and retainer plate assemblies (plates, bolts, washers and spring-type nuts), (Figure 3-10), used at the ends of each row should be obtained from the mounting structure manufacturer, or obtained locally by the installing contractor.

Direct, Single-mounted Collectors:

1. Before positioning the first collector on the UNISTRUT, remove the six sheet metal screws holding the transition cover at the base of the collector. Remove the transition cover and attach an end-of-row T-bracket (without pins) to the side of the collector that will face out, (Figure 3-9), using two bolts for each bracket. Removal of the transition cover is only required for end-of-row collectors.
2. Re-attach the transition cover with the six screws. Use two bolts to attach the other end-of-row T-bracket to the same side of the collector.
3. Slide the collector into place so that the T-brackets grip the UNISTRUTS. Finger tighten the retainer plates to the UNISTRUTS. (Figure 3-10).
4. Place one internal T-bracket (pinned) into each UNISTRUT and a pipe support bracket at the header end and continue installing internal collectors.
5. Verify the correct location and squareness of the first collector and secure the two retainer plates to the Unistruts.
6. To mount the adjacent collector, place tube support brackets over the pins of the T-brackets, (Figure 3-11), at the header end of the collector and slide the next collector laterally until the pins are fully inserted and the collectors are snug one to the other.

7. For subsequent collectors, insert a pinned T-bracket into each UNISTRUT and a tube support bracket at the header end and continue installing internal collectors.
8. At the end of each row, install the last collector as described in Steps 1-3. Insure that each collector is snug against the next and then secure the two retainer plates. The next step is installation of headers (Section 4).

Direct, Dual-mounted Collectors:

1. Before positioning the first collector on the UNISTRUTS, remove the six sheet metal screws holding the transition cover at the base of the collector. Remove the transition cover and attach the two end-of-row T-brackets (without pins) to the side of the collector that will face out, (Figure 3-9), using two bolts for each bracket. Removal of the transition cover is only required for end-of-row collectors.
2. Temporarily re-install the transition cover with one screw.
3. Slide the collector into place so that the T-brackets grip the UNISTRUT. Place one internal T-bracket (pinned), (Figure 3-9), into each UNISTRUT and insert into the corresponding holes in the collector frame. Assure the position and squareness of the collector and tighten the retainer plates (Figure 3-10) to the UNISTRUT.
4. To install subsequent internal collectors in the first row of the dual configuration, place one internal T-bracket (pinned), (Figure 3-11), into each UNISTRUT and insert into the corresponding holes in the collector frame. At the collector header end, a tube support bracket, (Figure 3-11), is inserted over the pins of the T-bracket at every other collector. Remove five of the six transition cover screws at the base of the collector and place the collectors on the UNISTRUT. With the brackets in place, slide the collector laterally until the pins are fully inserted and the collectors are snug one to the other.
5. At the completion of the row, the last collector is installed as indicated in Steps 1 and 2. Be sure all collectors in the row are snug one against the other before tightening down the two retainer plates.
6. The second row of the dual configuration is now mounted. Repeat Step No. 1.
7. Attach the end closure and cover to the header channel, (Figure 3-12). Re-install the collector transition cover and attach the bottom header channel to the collector (Figure 3-13) using the six screws previously removed. The outside edge of the channel should be 1/8" beyond the end of the collector to prevent overrun of the channel assemblies.
8. Remove the remaining transition cover screw from each collector on the bottom of the first row.
9. Place the collector and channel assembly on the UNISTRUT below the first collector row installed (Figure 3-14) with the T-brackets in position. Attach the header channel to the top collector using two of the screws

removed in Step 1.

10. Place an internal T-bracket (pinned) into each UNISTRUT and insert into the corresponding holes in the collector. Verify the correct location and squareness of the first collector, and secure the retainer plates, (Figure 3-14), to the UNISTRUT.

At the collector header end, a tube support bracket will be inserted over the pins of the T-bracket every other collector, alternately to those placed on the opposing row.

11. Continue to attach bottom channels to collectors and complete installation of internal collectors. At the end of the row, the last collector is installed as indicated in Steps 1, 7 and 9. Be sure all collectors in the row are snug one against the other before tightening down the two retainer plates. The next step is installation of headers (Section 4).

Strut-mounted Collectors

With bottom brackets completely installed and spacing verified, (Figure 3-7), the collectors are mounted as follows:

1. Install all transition struts (Figure 3-4) and top brackets to the bottom brackets.
2. Remove the six sheet metal screws and the transition cover at the bottom of the collectors.
3. Beginning at the end of a row, place collectors of the row between the bracket assemblies on the mounting surface with the flare nuts on the lower edge.
4. Lift the header end of the first collector and align the outside mounting bracket hole with a hole in the collector. Temporarily insert one bolt (finger tight) through the assembly. Before inserting a bolt in the mounting bracket on the opposite side of the collector, align the adjacent collector, position a tube support bracket (similar to Figure 3-11, between the two collectors, and temporarily insert a bolt. This procedure is repeated in sequence until the header end of all the collectors in the row is attached.
5. Lift the other end of each collector and attach to the transition strut/bracket in a similar manner to step 4. Use two bolts for each attachment bracket until the row is complete. Tube support brackets are not required at row ends.
6. Complete the assembly at the header end of each collector by adding one more bolt for each bracket attachment. Before completing attachment, check collector alignment.
7. Re-install the collector transition section covers using the six sheet metal screws removed in Step 2. The next step is installation of headers (Section 4).

Note:

Cross bracing of the collector support structure may be required.

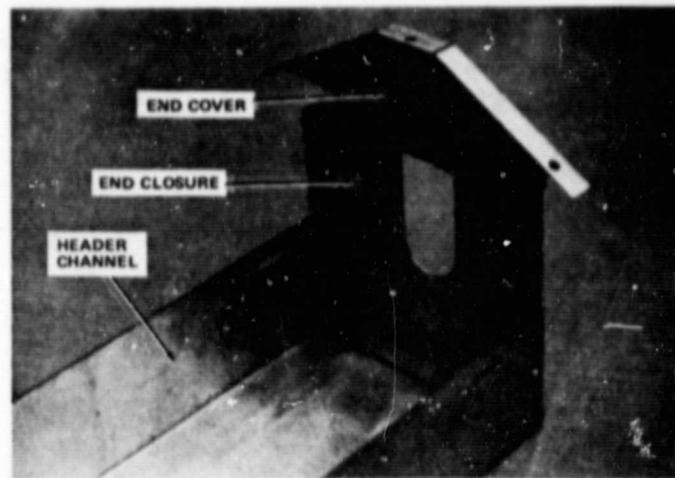


Figure 3-12. Attach End Closure and Cover for End-of-Row Collectors

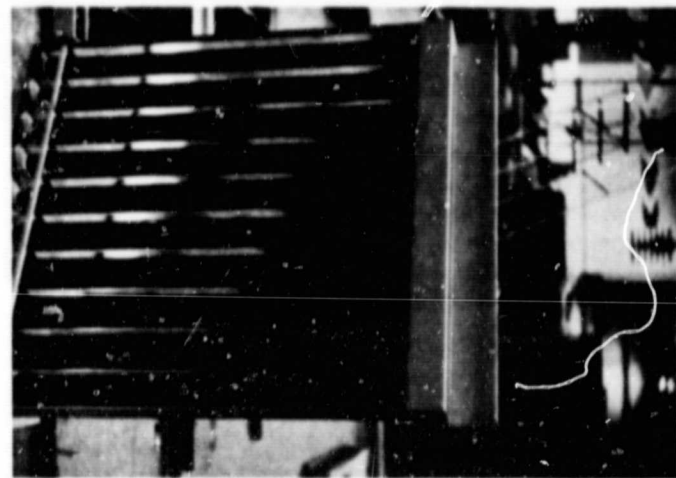


Figure 3-13. Attach Bottom Channel to the Collector

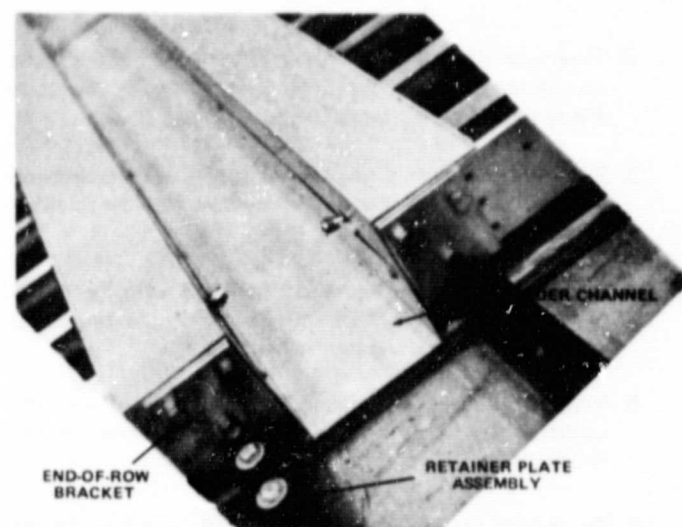


Figure 3-14 In Dual Arrangement, Place the Next Collector Below the First

4. COLLECTOR PLUMBING AND CHECKOUT

4.1 HEADER DESCRIPTION/PLUMBING

The TC-100 collector utilizes two 1/4-inch, 45-degree brass flare nuts for mechanical attachment to supply and return headers. These fittings protrude from the insulated transition section of the collector as shown in Figure 2-1. The design allows lateral flexibility in these connections, primarily to accommodate up to 3/4-inch lateral thermal expansion in the headers. These nuts are nominally 40 inches apart. Pipe headers may be used to supply one collector row (Figure 4-1) or two collector rows (Figure 4-2). Alternative designs may be utilized, provided all plumbing requirements are satisfied.

TC-100 collectors are designed for parallel flow circuit hookup and for uniform flow in each collector. Optimum performance is achieved at flow rates of 0.22 gpm/collector. Uniform flow distribution throughout the array is accomplished by providing comparable pressures to each header. Good distribution through the collectors connected to each header is achieved by sizing the headers for a pressure drop equal to or less than one-tenth that of the collector. Using this criteria, header sizes of 3/4 inch and 1-inch type-L copper tubing will provide uniform flow distribution for up to 18 and 36 collectors, respectively.

Type L copper tubing and wrought copper fittings are recommended throughout the collector loop to minimize galvanic reactions and eliminate the need for dielectric fittings. All non-mechanical connections should be soldered with 95-5 (tin-antimony) AWS (American Welding Society) class alloy. Headers require 1/4-inch 45-degree male fittings at specified locations to connect with the collectors. The installation of the header assembly should normally include thermal expansion devices, anchor clamps, and alignment clamps. Air removal from the collector loop is accomplished by an air separator, combined with an expansion tank. Air vents at the high points are not required.

The collector is designed with a hydraulic interface that can accommodate up to 3/4 inch of thermal expansion in the header piping. The piping design must preclude excessive loading on the collector tubing or header piping. To avoid excessive flare deformation and resultant leakage, torque fluid connections to the collector approximately 12-15 inch pounds.

Recommended manifold configurations showing optional General Electric header accessory kits are shown in Figures 5-4 and 5-9 for single and dual arrangements, respectively. The kits provide prefabricated header piping in 4- and 8-foot lengths with correctly-spaced tee fittings and male connectors, prefab insulation, covers, pipe clamps, header support brackets, and all the necessary fasteners. Dimensional specifications for 8-foot on-site assemblies are shown in Figure 4-3.

4.2 HEADER INSTALLATION PROCEDURES

It is recommended that the joining operation of lengths of headers be performed in place on the roof. In a "compact" array configuration for direct roof mounting, it is suggested

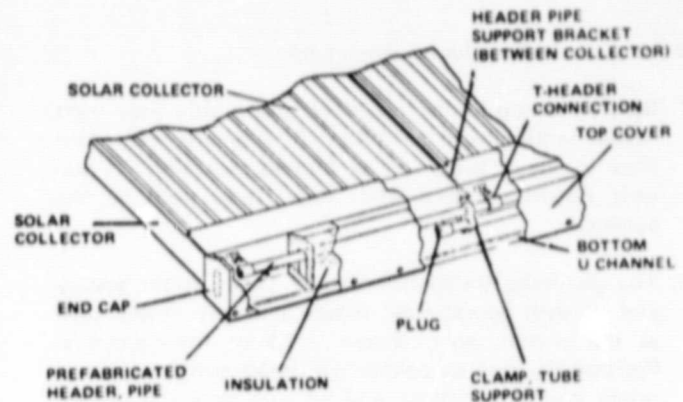


Figure 4-1. Single Collector Header Configuration

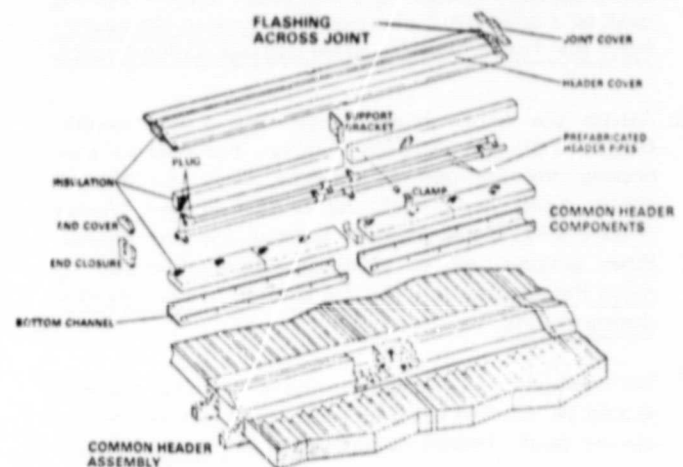


Figure 4-2. Dual Collector Header Configuration

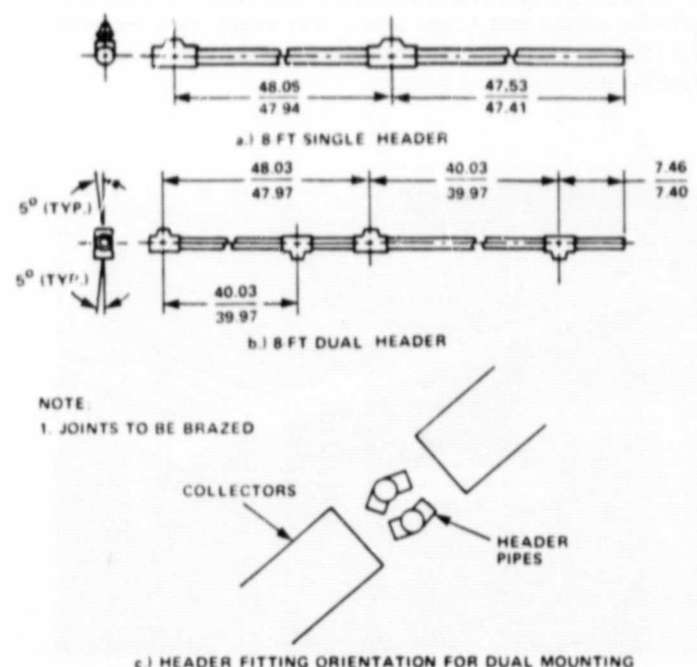


Figure 4-3. Header Dimensional and Orientation Requirements

that dual headering be employed and the plumbing installation be performed following installation of the collector frames and bottom channels. Thermal expansion compensators and clamps may be required.

Installation procedures for header tubing:

1. Before starting header assembly, thoroughly flush each header section with tap water. The supply and return lines to the headers will be flushed separately to prevent potential debris and water from entering the collectors.
2. The plumbing installation should begin at the supply end of each header row. Attach a supply header pipe as the bottom pipe, (Figure 4-4,) to the collectors. Position the pipe by connecting (finger tight) the appropriate collector fittings and be sure that the pigtails coming out of the collectors are centered in the slot. Braze adjacent headers and end plug(s). When brazing next to a collector connection Tee, remove the adapter from the Tee in order to avoid damage during brazing.
3. Attach the return header above the supply header, (Figure 4-4), just installed. Position the pipe by connecting the appropriate collector flare nut fittings (finger tight) and attach the header support clamps (Figure 4-5). Braze adjacent headers and end plug(s). When brazing next to a collector connection Tee, remove the adapter from the Tee in order to avoid damage during brazing.
4. With completion of header brazing in each row, adapters should be installed using lock-tite high-temperature pipe sealant (with Teflon) or equivalent (do not use tape).

Before connecting headers to supply and return, completely flush the supply and return pipes. For single-row collectors, insert the end covers onto the headers (Figure 4-6) prior to attachment of feeder connections.

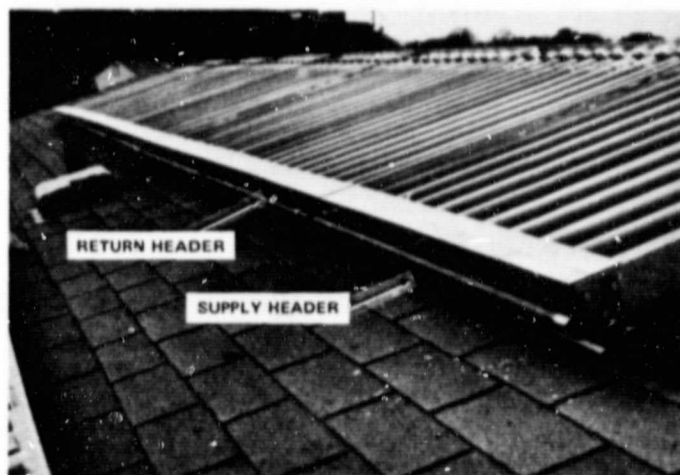


Figure 4-4. Install Headers

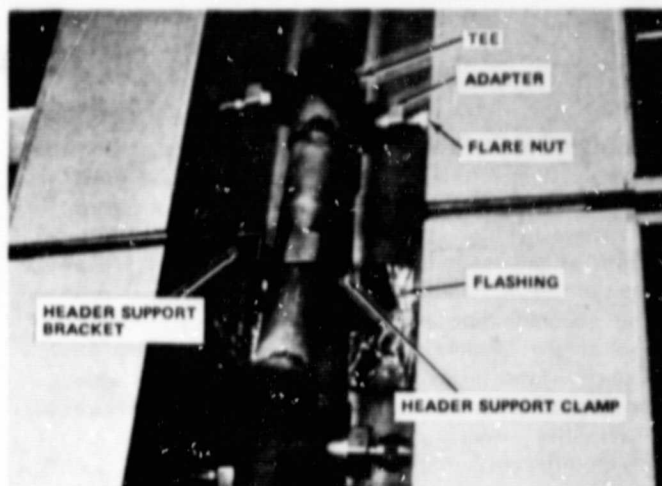


Figure 4-5. Connect Header to Collector Fittings and Attach Pipe Support Clamp

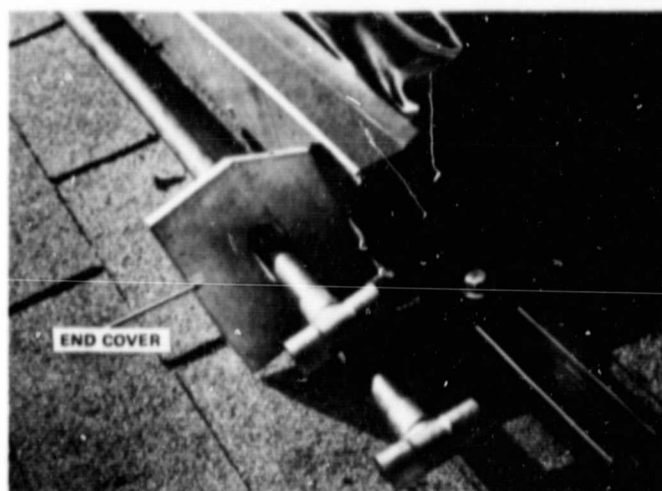


Figure 4-6. For Single Row Mounting, Insert End Covers

Caution must be exercised to prevent freezing of pipes during flushing. Flush the supply and return lines. When all header connections have been completed and the collector loop installation verified, the system is ready for a total collector system leak check.

4.3 LEAK TEST PROCEDURES

It is recommended that the collector loop be leak checked using compressed air by charging the system to 60 psig. Presence of leaks is indicated by loss of pressure within 4 hours. If leaks are indicated, all fittings and connections should be bubble tested (soap solution) and defective connections repaired.

Note:

Collectors are leak checked at the factory and do not require internal leak checking.

With the leak test completed, the collector loop can be filled to the prescribed level with working fluid (ethylene glycol/water as specified). Open the pressure relief valve to allow air to escape. When filled, the primary pump may be activated

and fluid circulated through the collector loop. A strainer in the collector loop, upstream of the pump, is mandatory during the initial operation to collect any residual installation particles. This strainer should have a bronze body and stainless steel 20-mesh screen.

Circulate the fluid for a minimum of two (2) hours. Re-inspect the entire loop for leaks and remove, inspect, clean and replace the strainer. Repeat this procedure until the strainer is clear of residual particles.

Installation Reminder

The Thermal Energy Storage Tank must be filled in the following manner to avoid an air bound tank. Add water at the top of the tank. The air displaced by the water must be exhausted at the expansion tank (normally in the Airtrol fitting). Add a corrosion inhibitor to the water.

5. FINAL ASSEMBLY AND CHECKOUT

Once leak tests have been completed, the control system and sequences verified, and the overall system is operation ready, installation of the glass vacuum tubes may proceed. After vacuum tube installation, a functional checkout at elevated temperatures is recommended with repeated cycling to verify plumbing integrity. With completion of high-temperature checkout, insulation, header covers and protective windows (if used) should be installed.

5.1 VACUUM TUBE INSTALLATION

Vacuum tubes are shipped in separate, protective containers with 10 tubes per container. The containers should be inspected for external damage upon receipt. The tubes are individually wrapped in black plastic bags. These bags should be kept sealed until installation. Although glass tubes can be installed by one person, two installers are recommended for ease of installation.

Caution:

The glass tubes (similar to fluorescent bulbs and vacuum bottles) could implode if improperly handled. Personnel handling the tubes must wear suitable eye and hand protection. (See Section 6.5).

The following procedures are recommended for installation of the glass vacuum tubes:

1. Inspect the reflector troughs in each collector and carefully remove any debris.
2. Activate collector and storage loop pumps to minimize temperature buildup in the headers.

If the system can not be operated, retain the black plastic bags on the tubes or cover the collector modules until the system is activated.

3. Glass installation begins by removing the wooden retainer bar. Raise the outer end of the fin-tube assembly 1-2 inches from the edge of the collector as shown

in Figure 5-1. Excessive deflection will damage the collector. Slide the plastic shroud off and discard.

4. Inspect and remove grit or foreign matter from the copper fin with a cloth or soft bristle brush.

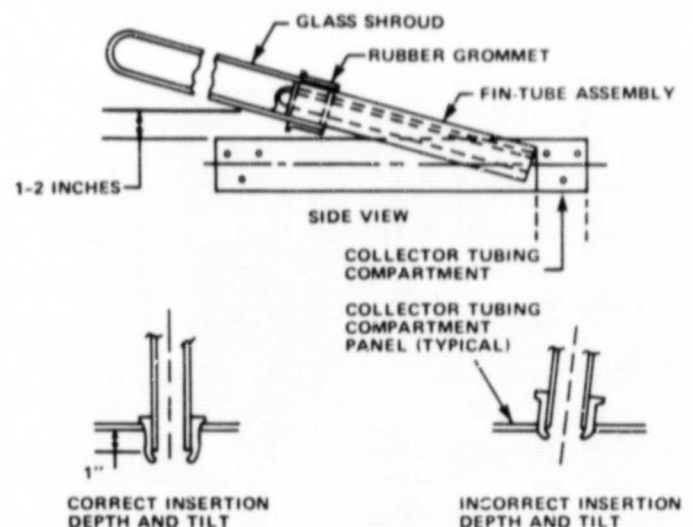
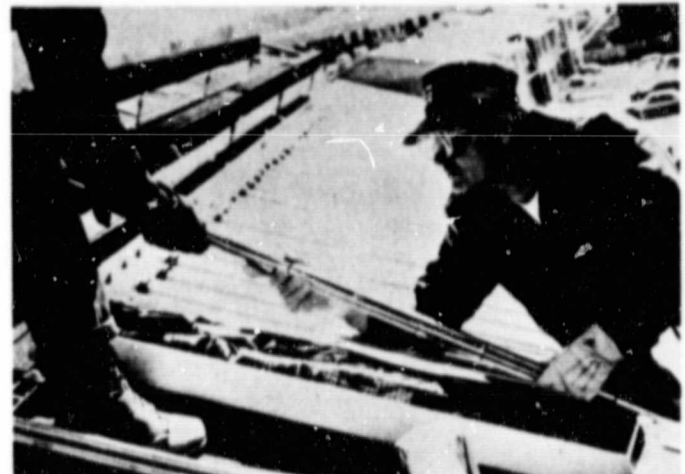


Figure 5-1. Glass Shroud Installation

5. The second installer should lightly support the fin tube to insure that it does not come in contact with the reflector trough and should continue to support the fin tube as the glass tube is installed.
6. Unseal the end of the protective black plastic bag at the open end of the glass tube and slide the glass tube over the fin tube assembly being careful not to bend or distort the cylindrical shape of the soft copper fin. Use the following procedure:
 - a. Lightly compress first fin segment leading edge between the thumb and first finger just enough to insert into the glass tube.
 - b. Center the open end of the glass tube over fin assembly and slowly slide on, (Figure 5-1).
 - c. Continue by slightly compressing the leading edge of each fin segment as the glass tube is installed until the tube has slid past the last fin segment.
7. Seat the glass tube and grommet into the hole in the collector panel, (Figure 5-2). Insure that the grommet is completely seated (snapped in place) for weather protection, (Figure 5-1).
8. Slide off the black plastic bag. The bags should remain on the glass tubes if the system is not ready for operation.
9. Install the metal spring clip retainer over the elastomeric bumper strip on the glass tube and into the two retaining holes in the reflector, (Figure 5-3).
10. Repeat procedure until the ten tubes are installed in each collector.

5.2 OPERATIONAL CHECKOUT

It is recommended that a total system operational checkout be performed with repeated cycling to elevated temperatures for several sunny days. After removing the black plastic bags from the glass tubes and assuming that checkout of the control system has been completed, operational checkout



Figure 5-2. Firmly Seat Grommet into the Collector

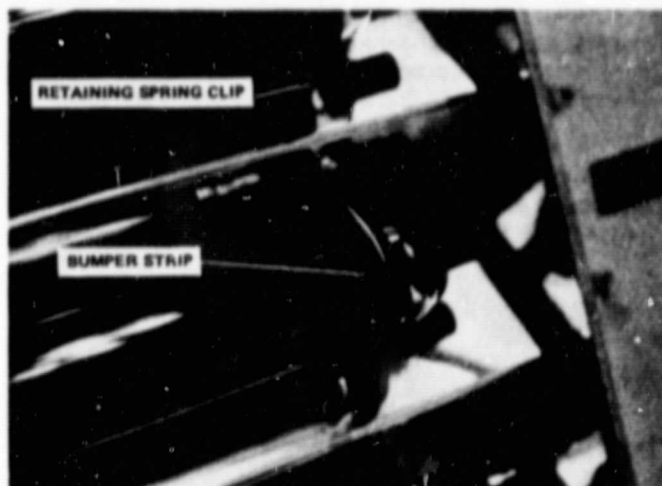


Figure 5-3. Install the Metal Spring Clip

can begin. On a bright day, the collector loop fluid will begin to get hot within 1/2 hour to 1 hour. Continue running in an energy collection mode without the storage pump, (P2, Fig. 6-1), running until the collector fluid temperature can be maintained between 200°F and 150°F for high-temperature tests. These tests will provide a comprehensive leak check for the collector loop as well as an operational checkout of the system. With regard to the collector loop, the following procedures are recommended:

1. After the first four hours of operation at elevated temperatures, perform a complete visual inspection of the collector loop and manifolds for leaks. If no leaks are found, proceed to Step 5.
2. If leaks are found, wait till low sunshine (or cover the collectors) and let the system cool down. Correct leaks.
3. Refill system and repeat high-temperature test procedure from start.
4. Repeat Step 1. If no leaks are found proceed to Step 5. If an additional leak is found, return to Step 2.
5. After a minimum of 2 sunny days of operation (2 high temperature cycles), check the strainer for residual particles and take a sample of the working fluid for analysis, (Section 6.2). Clean and replace the strainer. Perform a final visual inspection for leaks.

With the integrity of the loop piping under high temperature verified, the insulation may be installed and the final assembly of header covers and protective windows (if any) may proceed.

5.3 INSULATION AND COVER INSTALLATION

Pre-fabricated insulation is provided as an integral part of the General Electric header accessory kits. If General Electric header accessory kits are not used, 2 inches or more of fiberglass insulation is recommended with an appropriate moisture barrier on all outdoor headers. It is also recommended that 1-1/2 inches or more of fiberglass insulation be used on all indoor piping. The following procedures are established for use with the General Electric header accessory kits.

Note:

Select a low-sunshine day or keep the storage tank cool and pumps, (P1, P2 Fig. 6-1), running. This procedure is recommended to eliminate the hazard of hot header piping.

For single row header assemblies (Figure 5-4):

1. Remove the six sheet metal screws from the collector transition section for all collectors and without removing the covers, install the bottom channels using the same holes and screws, (Figure 5-5). The insulation is attached to this section.
2. Slide insulation away from joints to be sealed. Apply flashing (aluminized, water-proof tape) as needed inside the header channel over the gaps between collectors as a moisture barrier, (Figure 5-6). Re-position the insulation.
3. Install the covers by hooking the lips over the top of the collector transition section cover (Figure 5-7) and attach the covers to the bottom channel flanges with six (6) sheet metal screws.
4. Attach the end covers (Figure 5-8) which were installed with the piping, by positioning inside of the header cover and attaching with sheet metal screws.

Note:

End covers for the single header arrangement, if feeder connections are at the end of the row, must be installed on the header pipes during the plumbing sequence, (Figure 4-6), or must be cut to allow installation during final assembly.

5. Apply a silicone-based sealant around the gap before installing the joint covers. Install joint covers over the gaps between adjacent header covers with sheet metal screws as shown in Figure 5-4 and complete by crimping lips over the adjacent collector frames.
6. If optional protective windows (Figure 2-3) are used with the collectors, apply window standoffs to the Vee-troughs as specified. Install frames and clips as shown.

For dual row header assemblies (Figure 5-9), the bottom channel should be installed before plumbing. See Section 3.4, installation procedure for dual-mounted collectors.

1. Apply flashing (aluminized, water-proof tape) inside the header channel over the gaps between channels as a moisture barrier. Slide the bottom layer of insulation under the pipes. Slit the side insulation to fit around the collector connections and insert on both sides of the pipe, (Figure 5-10).
2. Install the cover, (Figure 5-11), by hooking the lip over the top of the upper collector transition section cover and push on the center of the cover to snap the bottom lip in place over the bottom transition cover. Screw onto the end covers.
3. Install joint covers over the gaps between adjacent header covers with sheet metal screws as shown in Figure 5-9 and complete by crimping lips on slotted end over the adjacent collector frames. Also, it is recommended that a silicon-based sealant be applied at the gap interface before installing the joint covers. Apply flashing to the end closures for weather proofing.
4. If optional protective windows, (Figure 2-3), are used with the collectors, apply window standoffs to the Vee-troughs as specified. Install frames and clips as shown.

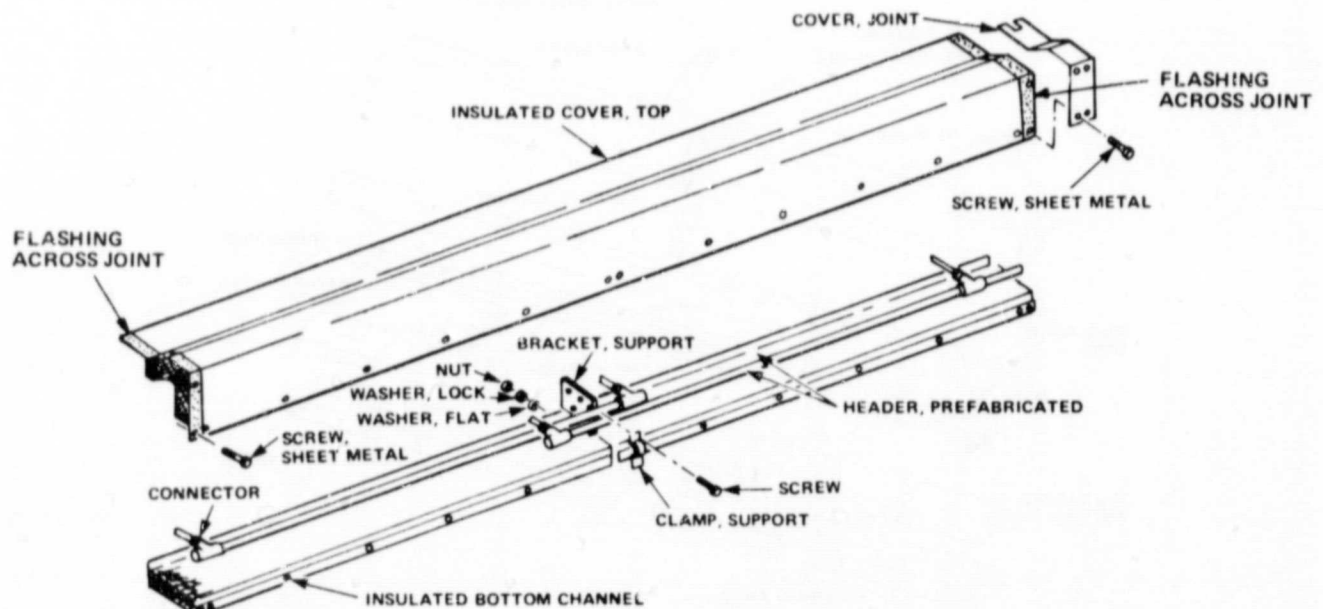


Figure 5-4. Assembly of Single Row Header Kit (8 Feet Long)

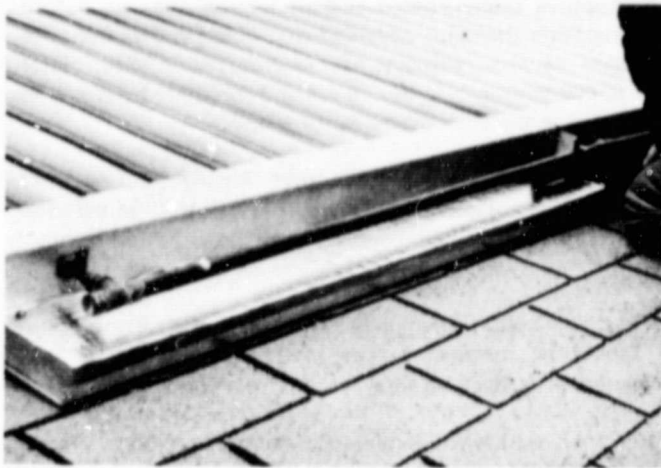


Figure 5-5. Install Bottom Channels

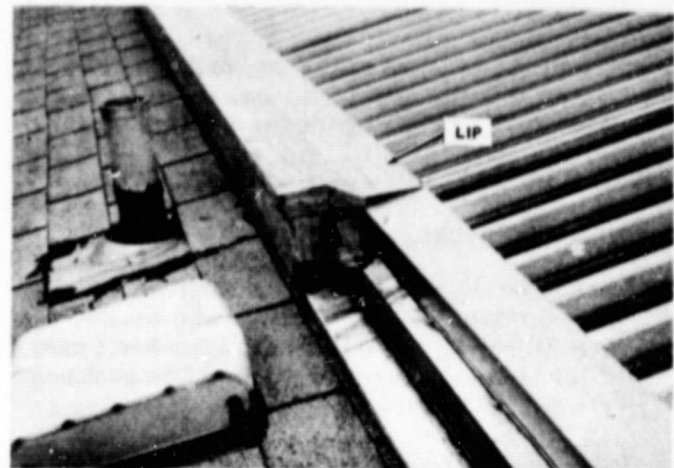


Figure 5-7. Install Cover

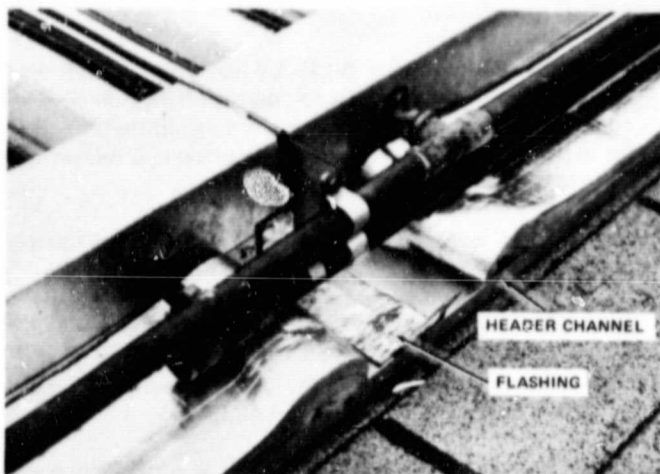


Figure 5-6. Apply Flashing

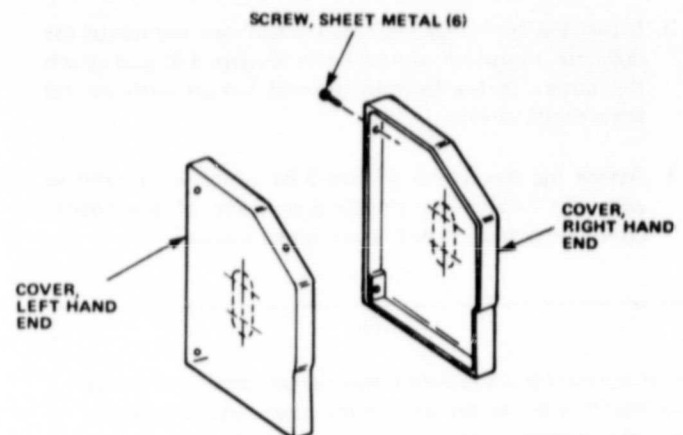


Figure 5-8. Single Row Header End Cap

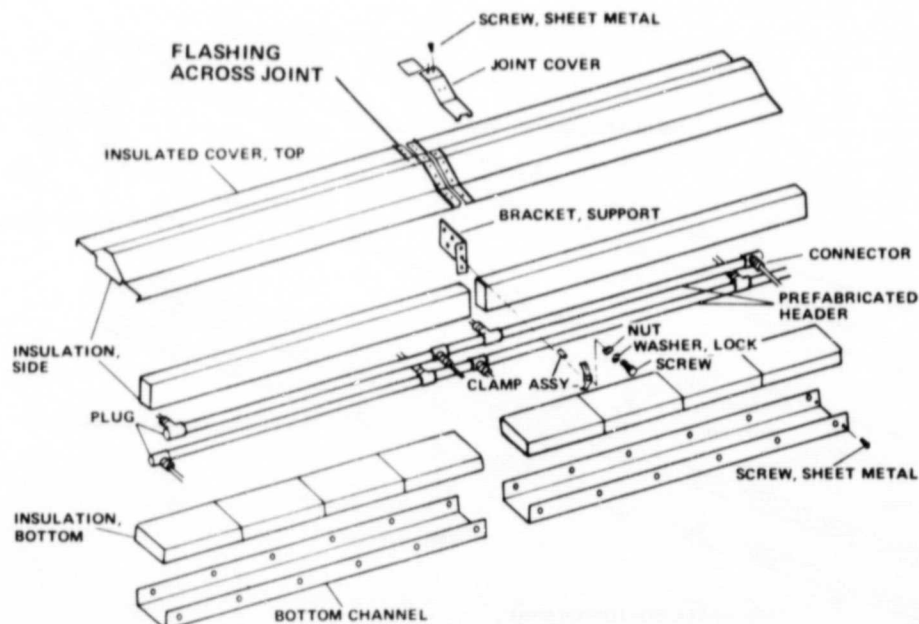


Figure 5-9. Assembly of Dual Row Header Kit (8 Feet Long)

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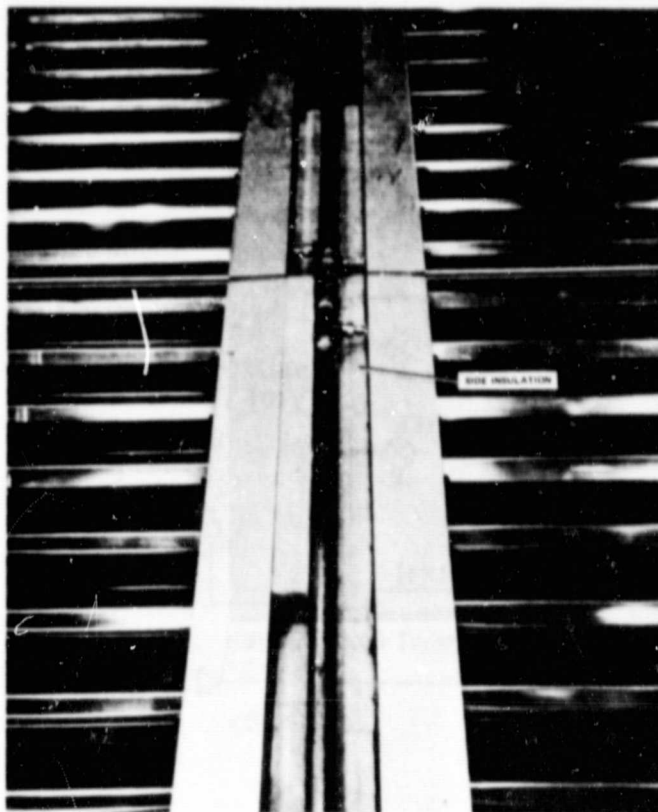


Figure 5-10. Insert Insulation Around Header Pipes

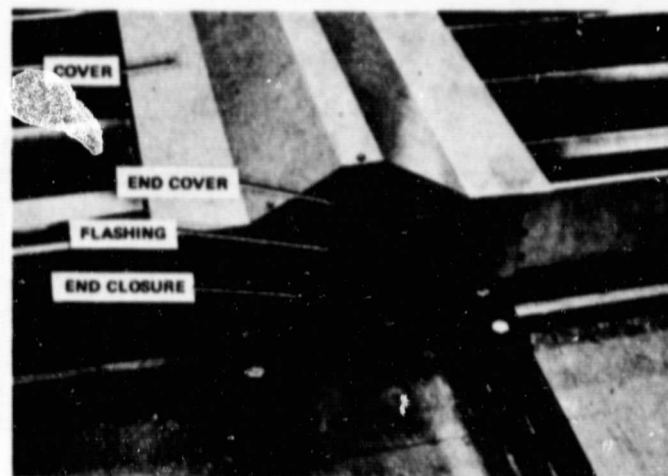


Figure 5-11. Install Cover

6. COLLECTOR LOOP OPERATION AND MAINTENANCE

6.1 COLLECTOR LOOP OPERATION

A recommended typical collector loop configuration for commercial installation is shown in Figure 6-1.

The collector loop is initially charged through the manual fill valve with the purge valve open and the shut off valve V101 closed. After the applicable fluid circulates through the collector loop and flows fully from the purge valve, open valve V101 and close the purge valve, then add an additional quantity of loop fluid, equivalent to approximately 10% of expansion tank volume, before closing the fill valve.

The optional solar controller, Figures 7-5 and 7-6, is used for normal daily start-up and shut-down. Although the factory set point for the controller is 35 Btuh/ft², the photo-sensor may be biased, as shown in Figure 7-6, to enable a higher value. Refer to General Electric Document 79SDS4231, for specific set point instructions.

At the required insolation level, the controller activates both the primary loop pump, P1, and the storage loop pump, P2. If the collector loop fluid temperature is less than 100°F, the diverter valve, V4, remains in the normal or "B" position, bypassing the primary heat exchanger. When the collector loop fluid temperature is greater than 100°F, diverter valve, V4, is

driven to the "A" position, allowing collected energy to be transferred to the thermal energy storage tank.

In the event that the storage tank becomes fully charged (i.e., 280°F) and the collector loop temperature exceeds 320°F, pumps P1 and P2 are de-energized. As the fluid remaining in the collectors increases in temperature, it expands through back pressure valve V1, which is set at 45 psig, into the expansion tank, TKX1. The limited amount of fluid in the collectors (max 0.12 gallon/module) will gradually vaporize, leaving the collectors dry until restart.

The sensor CT1, which is mechanically attached to a copper U-tube located inside a glass tube, inhibits restart at temperatures above 320°F.

6.2 PERIODIC MAINTENANCE

Collector loop fluid requires periodic inspection and/or maintenance to assure proper chemical balance and fluid level. An analysis is recommended for both water-glycol and all-water loops for the initial fill, quarterly samples for the first year, and yearly thereafter. Most commercial manufacturers of corrosion inhibitor additives offer a test kit for this purpose. Collector loop fluid composition is described in Section 2.3. Normal maintenance procedures should be used for other system components.

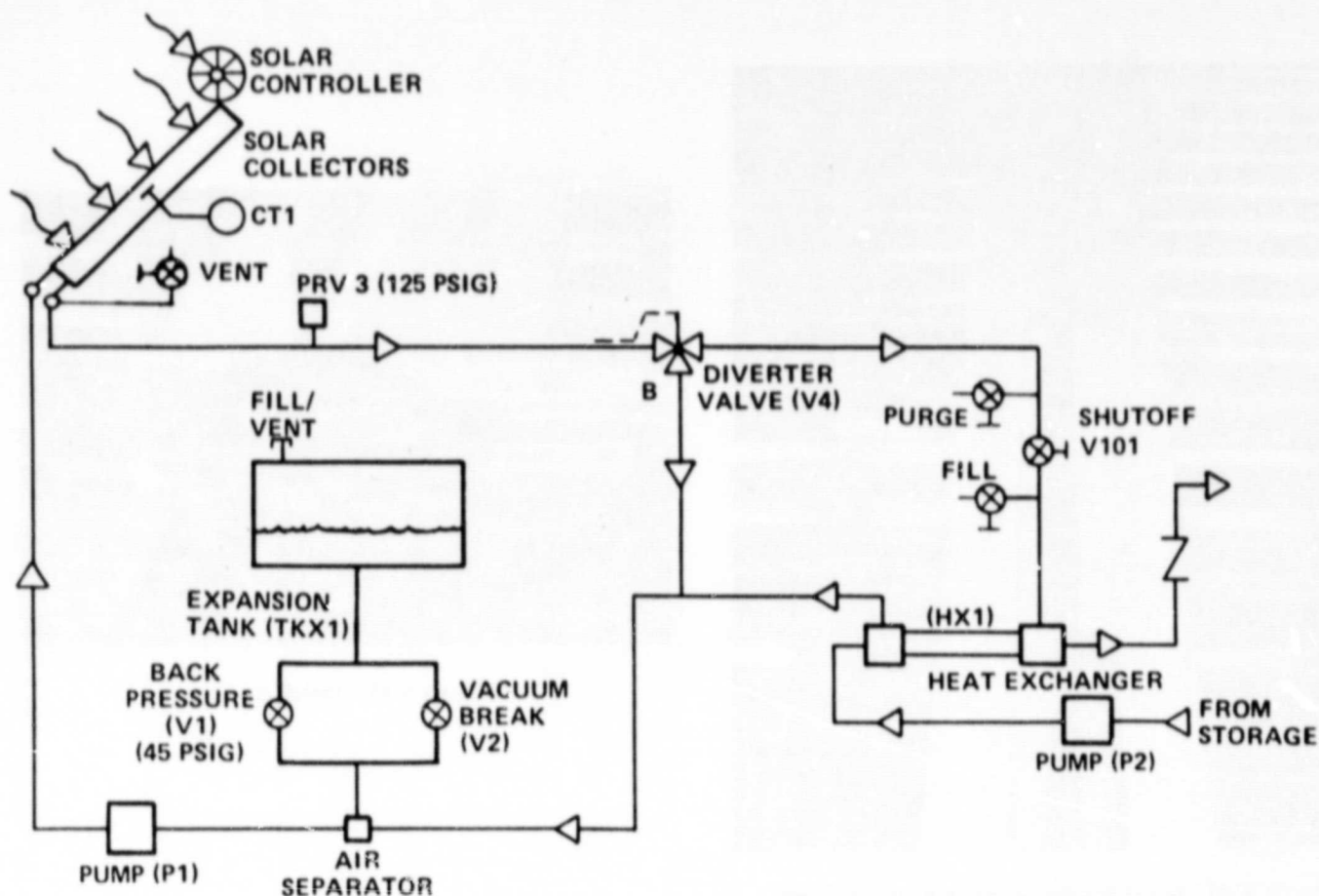


Figure 3-1. Typical Collector Loop

6.3 PERIODIC INSPECTION

The overall collector array should be periodically inspected for broken tubes and debris buildup in the reflector troughs. The frequency of this maintenance is a function of the location of a particular solar system and its environment.

6.4 GLASS TUBE REPLACEMENT

Remove the spring clip, (Figure 5-3), holding the shroud (vacuum tube) in place. The clip is flexed into two holes provided in the collector vee-trough reflector. Deflect the tube to be replaced upward no more than 1 to 2 inches from the edge of the collector and away from the vee-trough, (Figure 5-1). The tube will now slide off the collector fin-tube in the direction away from the header assembly. The boot on the tube at the header end of the collector should be removed with the tube being replaced as the new tube will contain a new boot. If the old tube is broken, be sure to clean the reflector completely and wipe down the fin assembly. After wiping down the fin-tube to eliminate all grit, the new tube is simply slid over the fin-tube, seating the boot into the bulk-head hole. Re-install the spring clip.

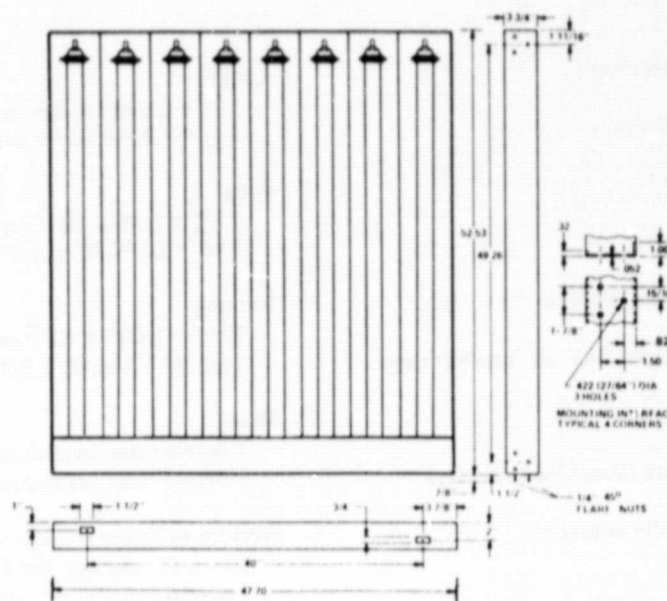
6.5 SAFETY CONSIDERATIONS

Handling of the vacuum tubes is comparable to handling

fluorescent bulbs. Caution must be exercised to avoid breakage and hot pipes. Protective gloves, clothing and safety goggles must be worn when inspecting or working on a system.

1. Glass vacuum tubes are evacuated and may implode if improperly handled.
2. In an operating system loop, fluid temperatures can reach 280°F. Hot pipes can be a safety hazard to personnel working around the pipes during final assembly and checkout. Personnel must be advised of loop temperatures and of appropriate provisions to cool down the system. Hand and eye protection is recommended when working around hot pipes.
3. Collector fluids composed of ethylene glycol are generally considered as showing a low order of toxicity except for oral ingestion. They do not vaporize at normal temperatures and, therefore, do not ordinarily constitute a hazard from inhalation. However, precautions should be taken against the vaporized fluid. Handling of waste fluid and its disposal should be in accordance with local ordinances.

7. SPECIFICATION DATA SHEET



PHYSICAL WEIGHTS

	British	SI
Frame Only	35 lbs.	16 kg
Glass Installed		
Dry	57 lbs.	26 kg
Wet	59 lbs.	27 kg

COMPOSITION

Frame	18 Ga aluminized steel (51.6 mil)
Reflector	Alglas TM
Insulation	Fiberglass
Fluid Lines	1/4" type L copper
Glass Tubes	008 soda lime

CONNECTIONS

Hydraulic	Brass 1/4" 45° Flare Nut
Structural Attachments	Stainless Steel or aluminum

EQUIPMENT SIZING GUIDELINES

Heat exchanger area		
Heating	.17 ft ² /module	.016 m ² /module
Cooling & Heating	.35 ft ² /module	.033 m ² /module
Storage Volume		
Heating Only	15 gallons/module	56.8 liters/module
Cooling & Heating	22 gallons/module	83.3 liters/module

OPERATIONAL

	British	SI
Insolation	0 to 400 BTU/ft ² /hr	0 to 108 langley
Fluid		
Operating Temperature	100 to 300°F	38 to 149°C
Composition	"Good" ¹ water with 35/50% Prestone II ^(m)	

MODULE DESIGN CONDITIONS

Pressure Drop-Design	7.0 psi @ 180°F	48.2 kPa @ 82°C
Minimum	5.0 psi	34.5 kPa
Flow Rate	0.22 gpm @ 180°F	0.83 l/m @ 82°C
Wind Velocity (Max)	100 mph	161 km/hr
Ice Load (Max)	13 psf	63.5 kg/m ²
Snow Load (Max)	20 psf	97.6 kg/m ²
Combined Load (Max)	33 psf	161.1 kg/m ²
Minimum Array Pressure	45 psi	310 kPa

MODULE AREA

Gross (Frame)	17.4 ft ²	1.62 m ²
Net (Active)	14.8 ft ²	1.38 m ²

¹ "Good" Quality Water:

Chlorides	< 100 ppm
Sulfates	< 100 ppm
Bicarbonates	< 100 ppm
Total Hardness	< 250 ppm

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ABBREVIATIONS

A	Refers to valve position
B	Refers to valve position
BTUH	BTU per hour
DHW	Domestic hot water
EMM	Energy Management Module
HVAC	Heating, ventilation and air conditioning
HX	Heat exchanger
Insolation	Solar radiation rate (Sunshine intensity)
M	Motor or electrically actuated
MMBTU	10^6 BTU
MO	Month
PRV	Pressure relief valve
T	Used with a number, denotes a temperature sensor
TC-100	General Electric Vacuum Tube Solar Collector
TES	Thermal energy storage tank
TKX	Expansion tank
V	Used with a number, denotes a valve
VT	Used with a number, denotes a temperature limiting valve
x or *	Symbol for multiplication
R_T	Tilt Correction Factor
K_T	Clearness Index
UA	Building Heat Loss Factor

SI CONVERSION UNITS

Length

$$1 \text{ in} = 0.0254 \text{ meter (exactly)}$$

$$1 \text{ ft} = 0.3048 \text{ meter (exactly)}$$

Area

$$1 \text{ in}^2 = 6.45 \times 10^{-4} \text{ meter}^2$$

$$1 \text{ ft}^2 = 0.09290 \text{ meter}^2$$

Volume

$$1 \text{ in}^3 = 1.639 \times 10^{-5} \text{ meter}^3$$

$$1 \text{ gal (U.S. liquid)} = 3.785 \times 10^{-3} \text{ meter}^3$$

Mass

$$1 \text{ ounce-mass (avoirdupois)} = 2.834 \times 10^{-2} \text{ kilogram}$$

$$1 \text{ pound-mass (avoirdupois)} = 0.4536 \text{ kilogram}$$

Pressure or Stress (Force/Area)

$$1 \text{ inch of mercury (60 F)} = 3.377 \times 10^3 \text{ pascal}$$

$$1 \text{ pound-force/inch}^2 \text{ (psi)} = 6.895 \times 10^3 \text{ pascal}$$

Energy

$$1 \text{ foot-pound-force (ft-lbf)} = 1.356 \text{ joule}$$

$$1 \text{ Btu (International Table)} = 1.055 \times 10^3 \text{ joule}$$

Power

$$1 \text{ watt} = 1 \times 10^7 \text{ erg/second}$$

$$1 \text{ Btu/h} = 0.2929 \text{ watt}$$

Temperature

$$t_C = 5/9 (t_F - 32)$$

Heat

$$1 \text{ (Btu}\cdot\text{in)} / (\text{h}\cdot\text{ft}^2\cdot\text{F}) \cdot 1.442 \times 10^{-1} = \text{W}/(\text{m}\cdot\text{K})$$

(thermal conductivity)

$$1 \text{ (Btu)} / (\text{lbm}\cdot\text{F}) \cdot 4.184 \times 10^3 = \text{J}/(\text{kg}\cdot\text{K}) \text{ (specific heat)}$$

Solar terms

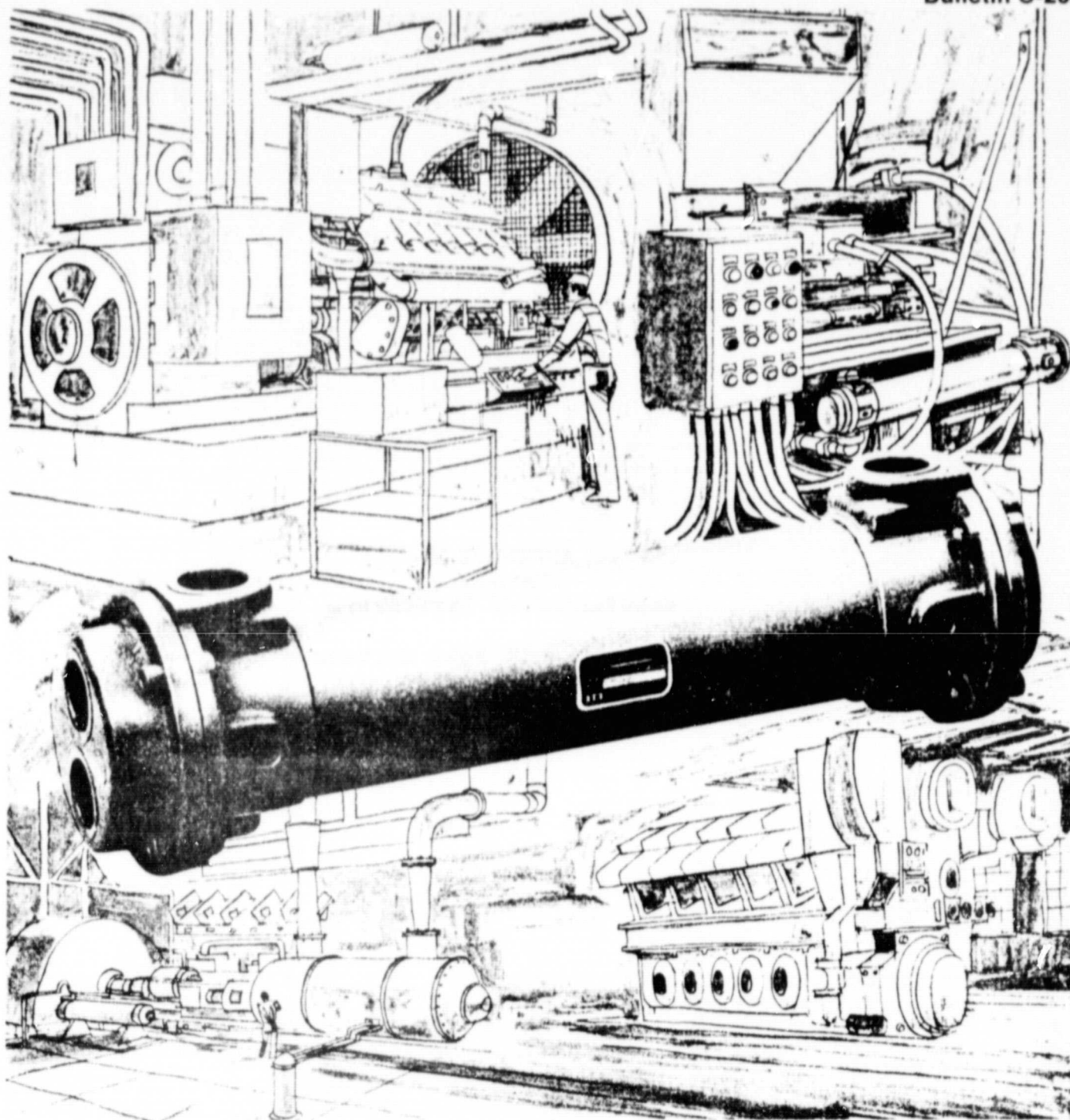
$$1 \text{ Btu/ft}^2 = .271 \text{ langley} = .271 \text{ cal/cm}^2 = 1.136 \text{ joule/cm}^2$$

GENERAL  ELECTRIC

APPENDIX E

Manufacturers Literature

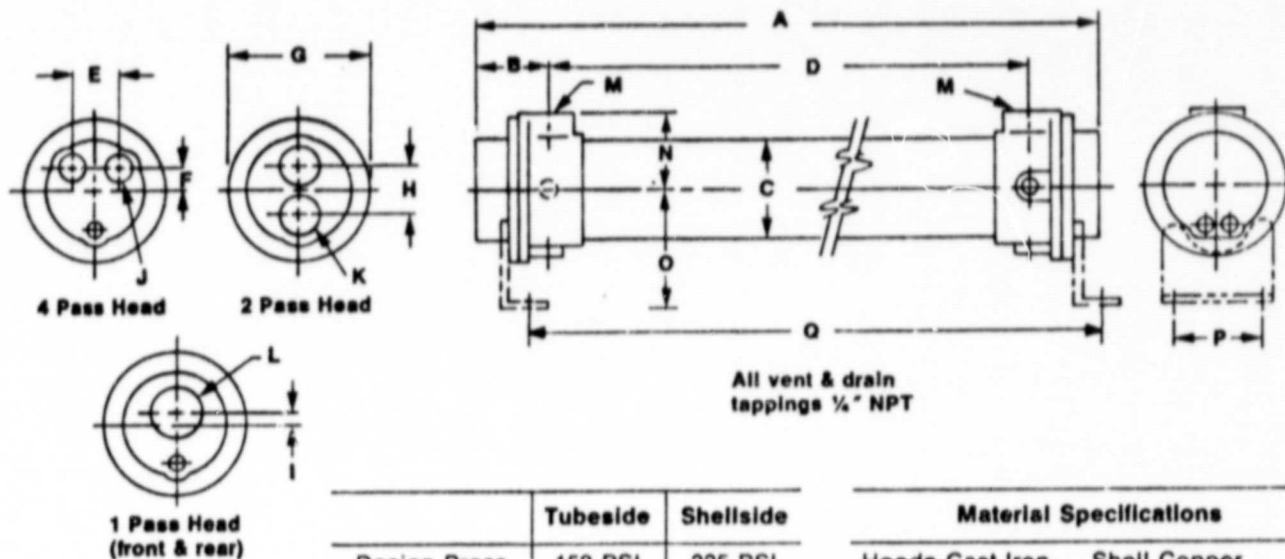
Bell & Gossett Heat Exchanger



Fixed Tube Sheet Heat Exchanger

Liquid to Liquid
Liquid to Gas
Cooling and Heating

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	Tubeside	Shellside
Design Press.	150 PSI	225 PSI
Test Press.	200 PSI	300 PSI
Design Temp.	300°F	300°F

Material Specifications	
Heads-Cast Iron	Shell Copper
Tubesheets-Brass	Shell Ends-Brass
Tubes-STH300&400 Series 1/4 in. copper	
STH500&600 Series 3/8 in. copper	

MODEL	AREA sq. ft.	1 Pass		2 Pass		4 Pass		C in.	D in.	E in.	F in.	G in.	H in.	I in.	J NPT	K NPT	L NPT	M NPT	N in.	O in.	P in.	Q** in.	Approx. Wt.
		A in.	B in.	A in.	B in.	A in.	B in.																
STH-310-*	4.2	17%		17%		17%		13														15%	16
STH-315-*	5.9	23%	2%	23%	2%	23%	2%	19	1 1/2	1/2	1/2	4 1/2	1 1/2	1/2	1/2	1	1 1/2	1	2 1/2	2 1/2	3 1/2	21%	19
STH-320-*	7.6	29%		29%		29%		25														27%	22
STH-410-*	7.2	17%		17%		17%		12 1/2														15%	22
STH-415-*	10.0	23%	2%	23%	2%	23%	2%	18 1/2	1 1/2	1 1/2	1 1/2	5 1/2	1 1/2	1 1/2	1	1	2	1 1/2	3	3 1/2	3	21%	32
STH-420-*	12.9	29%		29%		29%		24 1/2														27%	46
STH-515-*	13.0	24%		24%		23%		18 1/2														21%	50
STH-520-*	16.7	30%	3%	30%	3%	29%	2%	24 1/2	2 1/2	1 1/2	1 1/2	6 1/2	2 1/2	1 1/2	1	1 1/2	2 1/2	1 1/2	3 1/2	4 1/2	3 1/2	27%	56
STH-530-*	24.0	42%		42%		41%		36 1/2														39%	68
STH-620-*	28.2	31%		30%		30%		24														27%	74
STH-630-*	40.8	43%		42%		42%		36														39%	93
STH-640-*	53.4	55%	3%	54%	3%	54%	3%	48	2 1/2	1 1/2	1 1/2	7 1/2	3 1/2	1 1/2	1 1/2	2	3	2	4 1/2	4 1/2	3	51%	112
STH-650-*	66.0	67%		66%		66%		60														63%	131

*No. of passes, either 1, 2 or 4.

**Dimension for this arrangement only

Note: Dimensions subject to change without notice

APPENDIX F
System Drawings

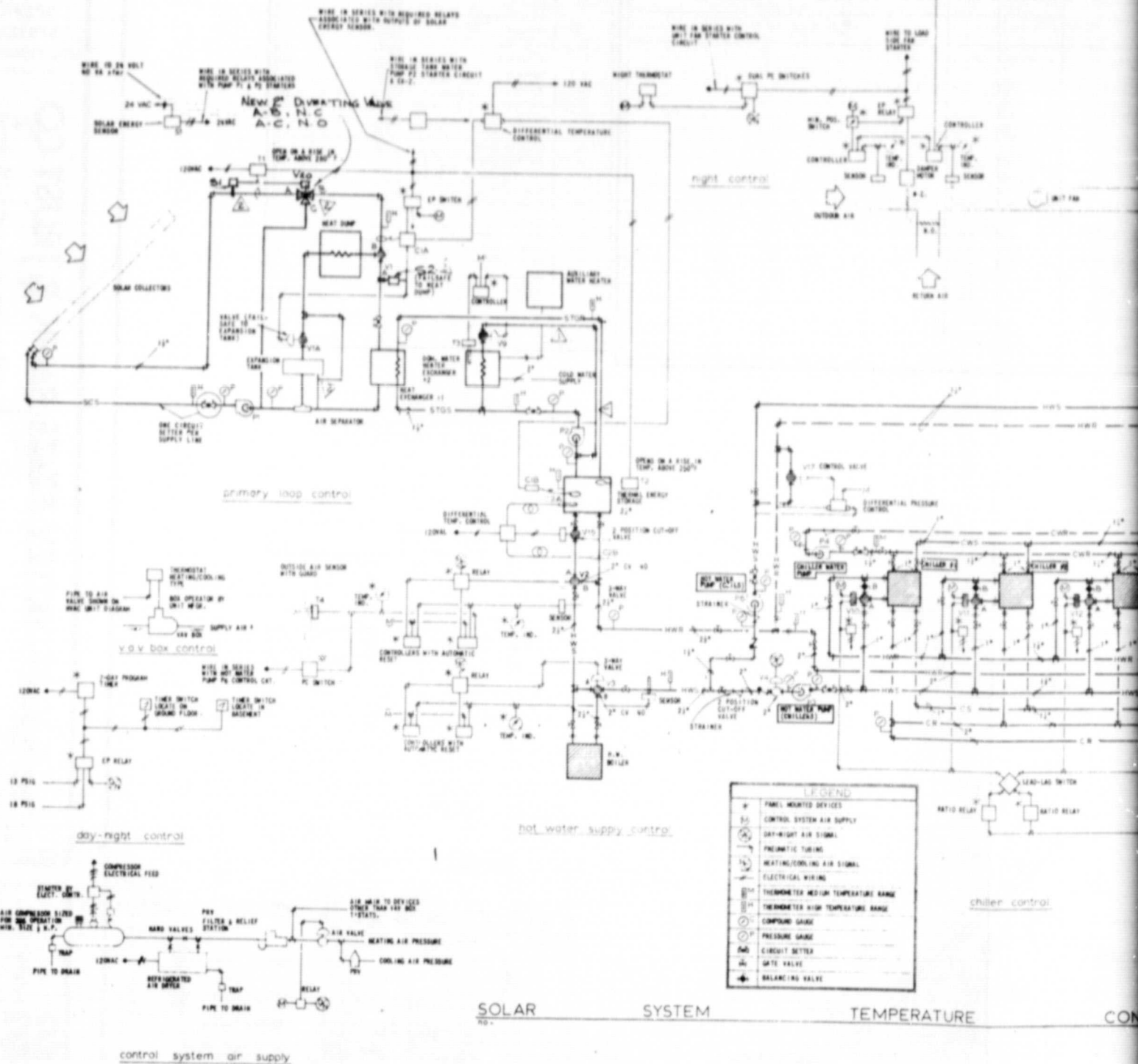
CONTROL SEQUENCE

The new 2" diverting valve shall be pneumatic return, slow opening and fast closing. The valve shall be normally open "A" to "C", and normally closed "A" to "B". On temperature rise to 75°F, the valve shall position "A" to "B". On a temperature drop to 65°F, the valve shall position "A" to "C".

SI CONTROL

Should sensor S2 see a temperature of 10°F, Pump P1 will be turned off and a red indicating light turned on. A manual reset will be required to restart Pump P1. The red indicating light shall be located, as directed by the architect, in the automatic teller room. The reset station shall be in the storage tank room.

RESTART MUST BE BY THE MASTER FOR PUMP P1.



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FOLDOUT FRAME

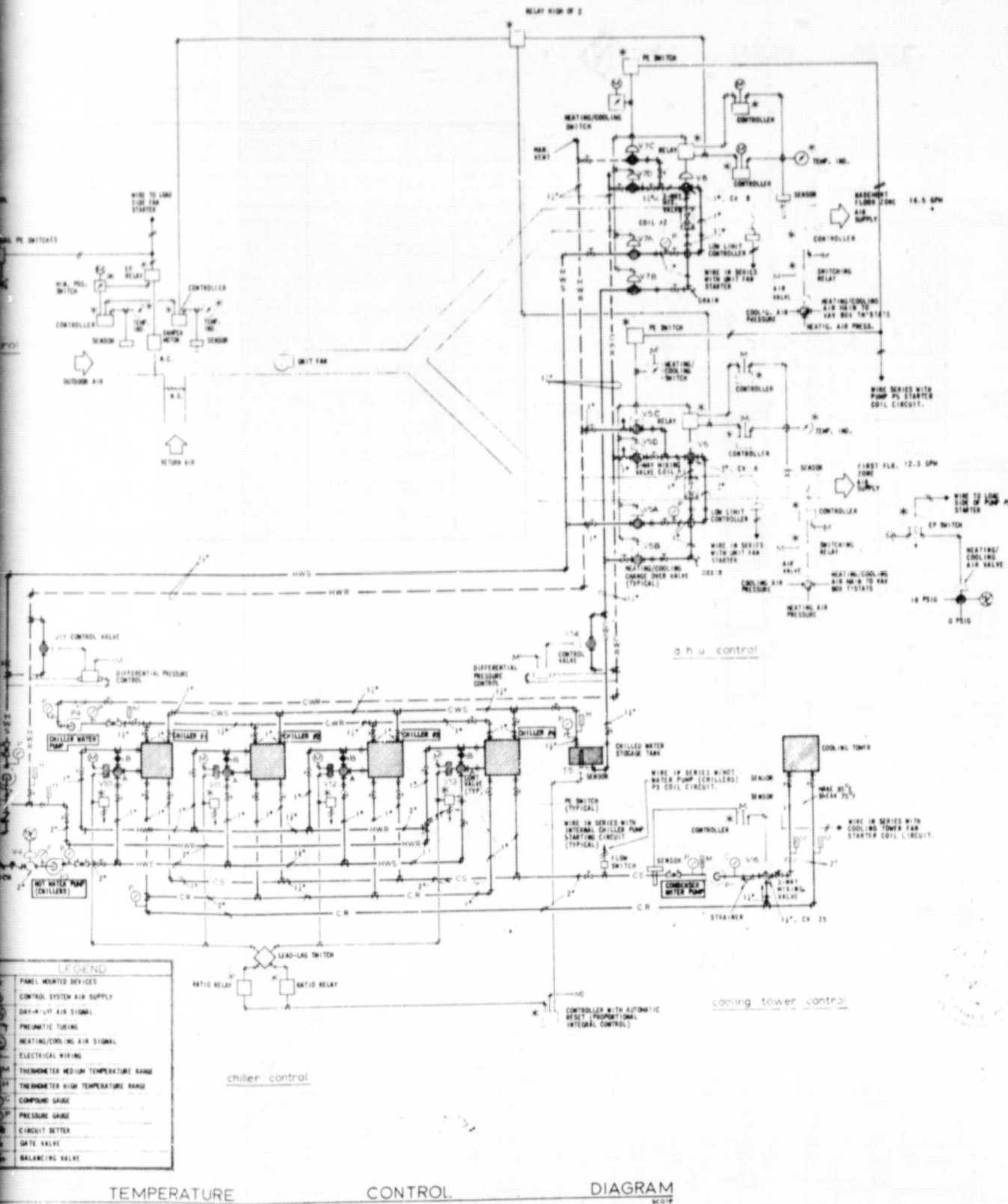
REVISIONS	BY
1/22/77	DMH
7/22/80	WED

SOLAR SYSTEM MODIFICATION

KAW VALLEY STATE BANK & TRUST CO.

DESIGNED BY: JAMES L. HARRIS, ARCHITECTS
 1001 N. 10TH ST., OKLA. CITY, OKLA. 73102

DRAWN: G.C.P.
 CHECKED: W.E.D.
 DATE: 11-17-77
 SCALE: AS INDICATED
 JOB NO.: 761126
 SHEET: **SS-2**
 OF 7 SHEETS



TEMPERATURE CONTROL DIAGRAM

